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For some time it has been apparent that this year would be the most prosperous in the history of the Hudson company. But not until the Big Shows were past did we fully realize the extent of Hudson prosperity.

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If you are a dealer of the Hudson type, write and find out how you may share in its prosperity. There are only a few opportunities. You must act now.

HUDSON SUPER SIX

Hudson Motor Car Company
Detroit, Mich.

(D)

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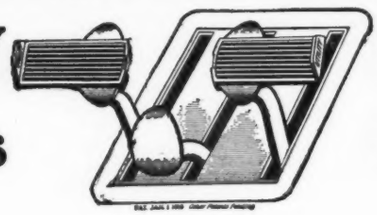

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AUTOMOTIVE INDUSTRIES
The AUTOMOBILE

VOL. XL NEW YORK—THURSDAY, MARCH 20, 1919—CHICAGO NO. 12

Proper Systems Reduce Labor Turnover

Wide Variation in Turnover Percentages Due to Factory Methods—Many Plants Have Over 500 Per Cent Yearly

WASHINGTON, March 13—If a worker remains in the factory for more than three months the chances are two to one that he will be permanent. Twenty-one per cent of the men hired in Detroit leave their jobs before they finish one week's work. Fifteen per cent work less than 2 weeks, 14 per cent less than one month, 17 per cent from 1 to 3 months, 11 per cent 3 to 6 months, 8 per cent 6 months to 1 year and after 1 year the percentage decreases rapidly from 6 per cent quitting their jobs after working less than 2 years to 1 per cent quitting after being employed 5 years. This indication of the heavy labor turnover that exists in Detroit is the result of an intensive investigation of this problem by the Department of Labor, which has examined the length of service of workers, the nature of their separations and the causes. A comparison was made between Cleveland and Detroit.

High Turnover in Detroit

Labor turnover was found to be considerably higher in Detroit, where more than one-fifth of the firms had a turnover exceeding 400 per cent and two-fifths a turnover exceeding 300 per cent, as compared with Cleveland, where more than three-fourths of the establishments had a turnover of less than 300 per cent.

The greater turnover in Detroit is due to the more intense competition for labor, especially during the war period, when Detroit concerns seemed most actively engaged in war work. There has, in addition, always been a more noticeable turnover of labor in those cities which confine their activities chiefly to one specific industry. In Akron, where the tire industry is the chief occupation, a similar class of migratory worker floating from one factory to another and back again is also noticeable.

Specially trained executives, welfare systems, well organized labor departments, fairness, good wages, and consideration of promotion and service for employees show definitely in the investigation of the Department of Labor that they tend to lower the turnover.

Considerations That Reduce Turnover

Table 1 shows in detail the extent of labor turnover in 37 Cleveland establishments.

This table shows that more than 60 per cent of the Cleveland firms had an annual turnover exceeding 200 per cent, while 25 per cent of the companies exceeded 300 per cent.

There are no companies listed with a turnover of less than 50 per cent, 4 are under 100 per cent, 5 under 150 per cent, 5 under 200 per cent, 7 under 250 per cent, 7 under 300 per cent, 5 under 350 per cent, 4 under 400 per cent and none over this figure.

Examination of the general causes for the extent of turnover shown was made by investigating those companies with the lower and higher turnover. Establishment No. 17, employing an average of 1004 persons daily, had the largest turnover, 368 per cent, and in this company it was found that there was no attempt made to operate a properly organized

TABLE 1—LABOR TURNOVER FOR YEAR ENDING JUNE 1, 1918, IN 37 ESTABLISHMENTS, CLEVELAND, OHIO

Establishment No.	Number Hired	Separations: Discharged	Separations: Laid Off	Separations: Entered Military Service	Separations: Quit	Separations: Total	Average Number Employed per Day	Per Cent of Turnover for Year	Industry or Nature of Business
[1]	3,552	156	22	529	2,171	2,878	4,456	65	Automobile.
2	7,011	[2]	[2]	[2]	[2]	3,718	3,124	119	Metal products.
3	[2]	2,709	.....	270	6,651	9,630	2,712	355	Metal products.
4	[2]	[2]	[2]	[2]	[2]	3,037	2,430	125	Metal products.
5	7,367	[2]	[2]	[2]	[2]	6,525	2,222	294	Steel manufacturing.
6	5,179	1,095	470	274	4,450	6,289	2,173	289	Automobile.
7	6,075	429	406	315	4,439	5,589	1,987	281	Storage batteries.
8	5,118	275	118	200	4,488	5,081	1,649	308	Metal products.
9	6,036	763	.....	57	4,969	5,789	1,610	359	Storage batteries.
10	3,009	[2]	[2]	[2]	[2]	4,030	1,514	266	Woodwork.
[3]11	[2]	[2]	[2]	[2]	[2]	1,611	1,757	92	Clothing.
12	2,643	188	6	66	2,663	2,923	1,417	206	Automobile.
13	2,328	353	1	2	1,906	2,262	1,368	173	Telephone service.
14	2,200	20	513	147	2,209	2,889	1,267	228	Telephone service.
15	3,520	[4]	[4]	216	[5]2,340	2,556	1,263	202	Metal products.
16	[2]	320	.....	[4]	[6]2,521	2,841	1,031	276	Steel (Canton).
17	3,378	[2]	[2]	[2]	[2]	3,698	1,004	368	Bags.
18	1,575	[2]	[2]	[2]	[2]	1,338	984	136	Metal products.
19	2,691	58	15	166	2,154	2,393	940	255	Storage batteries.
20	3,077	[2]	[2]	[2]	[2]	3,091	937	330	Iron castings.
21	1,286	11	26	42	1,307	1,386	917	151	Metal products.
22	[2]	[2]	[2]	[2]	[2]	2,076	770	270	Automobile frames.
23	[2]	[2]	[2]	[2]	[2]	573	753	76	Gas.
24	2,392	206	45	156	1,927	2,334	709	329	Wire and hot-rolled rods
25	1,510	96	18	79	1,327	1,520	699	217	Wire, rods, nails.
26	1,281	84	.....	45	1,161	1,290	590	219	Metal products.
27	941	[2]	[2]	[2]	[2]	776	393	197	Electrical appliances.
28	1,455	167	552	132	432	1,283	384	334	Tractors.
29	1,016	[2]	[2]	[2]	[2]	1,038	344	302	Street-railway cars.
30	[2]	[2]	[2]	[2]	[2]	158	304	52	Gas.
31	568	50	.....	20	478	548	267	205	Paint and varnish.
32	[2]	[2]	[2]	[2]	[2]	443	205	216	Brushes.
33	225	[2]	[2]	[2]	[2]	265	163	163	Printing.
34	[2]	[2]	[2]	[2]	[2]	232	149	156	Printing.
35	[2]	[2]	[2]	[2]	[2]	376	105	358	Paint and varnish.
36	132	23	.....	9	108	140	102	137	Telephone service.
37	[2]	[2]	[2]	[2]	[2]	139	98	141	Molding.

[1]For year ending April 1, 1918.
[2]Not reported.
[3]The turnover information shown here is based upon the records of five individual establishments. It was obtained in connection with another investigation carried on simultaneously in the cloak and suit industry of Cleveland.
[4]Included in "Quit."
[5]Includes "Discharged" and "Laid Off."
[6]Includes "Entered Military Service."

TABLE 2—LABOR TURNOVER FOR YEAR ENDING JUNE 1, 1918, IN 42 ESTABLISHMENTS, DETROIT

[1]	14,924	169	110	3,122	11,230	[2]14,631	31,950	46	Automobile.
2	34,779	4,886	2,085	2,304	20,916	30,191	11,405	265	Automobile.
[3]	41,174	5,115	3,799	2,727	34,167	45,808	11,125	412	Automobile.
4	16,696	[3]	[3]	1,496	[4]15,552	17,048	6,337	269	Automobile.
5	[5]	[6]4,948	[5]	[5]	10,182	15,130	3,379	448	Metal products.
[7]6	2,332	[5]	[5]	[5]	[5]	2,527	2,925	86	Coke and chemicals.
7	7,683	[5]	[5]	602	[5]	6,861	2504	274	Automobile.
8	3,347	548	4	[5]	2,463	3,015	2,167	139	Telephone service.
9	7,332	965	1,879	362	3,581	6,787	1,944	349	Automobile.
10	585	94	.....	137	809	1,040	1,933	54	Gas, illuminating.
11	[5]	747	242	317	4,489	5,795	1,103	525	Metal products.
[8]12	2,427	634	406	[3]	1,227	2,267	850	267	Metal products.
13	1,629	116	306	63	1,638	2,123	783	271	Metal products.
14	3,591	713	.....	[3]	[9]2,871	3,584	726	494	Metal products.
15	[5]	[5]	[5]	[5]	[5]	1,642	675	243	Metal products.
[7]16	1,037	112	.....	95	924	1,131	668	169	Chemicals, drugs.
[7]17	1,781	[5]	[5]	[5]	[5]	1,714	637	269	Metal products.
18	1,773	113	.....	130	1,190	1,433	630	227	Metal products.
19	2,682	65	.....	.....	2,600	2,665	591	451	Tobacco.
20	1,642	298	.....	[3]	[10]1,467	1,765	511	345	Furniture.
21	834	44	[3]	41	[11]1,082	1,167	497	235	Metal products.
22	686	55	.....	25	898	978	480	204	Clothing.
23	3,000	[5]	[5]	[5]	[5]	3,040	475	640	Paper.
24	[5]	365	.....	45	1,464	1,874	456	411	Food products.
25	1,967	168	.....	84	1,805	2,057	438	470	Metal products.
26	533	66	37	89	318	510	431	118	Telephone service.
27	1,296	63	24	67	912	1,066	390	273	Metal products.
28	628	51	26	106	450	633	331	191	Telephone service.
29	910	102	250	53	290	695	316	220	Metal products.
30	968	137	.....	68	694	899	241	373	Metal products.
31	800	[5]	[5]	[5]	[5]	670	224	299	Metal products.
32	392	18	.....	22	344	384	218	176	Metal products.
33	744	125	.....	33	586	744	213	349	Electrical appliances.
34	[5]	[5]	[5]	[5]	[5]	710	187	380	Metal products.
35	543	43	27	15	482	567	161	352	Metal products.
36	104	15	3	20	68	106	161	66	Telephone service.
37	[5]	[5]	[5]	[5]	[5]	391	159	246	Electrical manufactures.
38	167	13	20	13	95	141	138	102	Telephone service.
39	477	52	260	42	183	537	135	398	Automobile manufacturing.
40	606	148	32	64	369	613	121	507	Automobile manufacturing.
41	[5]	120	.....	30	273	423	114	371	Metal products.
42	[5]	[5]	[5]	[5]	[5]	298	86	347	Metal products.

[1]Year ending August 1, 1918.
[2]Excluding transfers.
[3]Included in "Quit."
[4]Includes "Discharged" and "Laid Off."
[5]Not reported.
[6]Includes "Laid Off" and "Entered Military Service."
[7]Year ending July 1, 1918.
[8]No males employed in establishment.
[9]Year ending February 1, 1918.
[10]Includes "Entered Military Service."
[11]Includes "Laid Off."

TABLE 3—NUMBER AND PER CENT OF SEPARATIONS ATTRIBUTABLE TO EACH SPECIFIED CAUSE

SIXTEEN ESTABLISHMENTS IN CLEVELAND

Establishment No.	Number: Discharged	Number: Laid Off	Number: Entered Military Service	Number: Quit	Number: Total	Per Cent: Discharged	Per Cent: Laid Off	Per Cent: Entered Military Service	Per Cent: Quit
12	188	6	66	2,663	2,923	6	[1]	2	91
6	1,095	470	274	4,450	6,289	17	7	4	71
1	156	22	529	2,171	2,878	5	1	18	75
7	429	406	315	4,439	5,589	8	7	6	79
19	58	15	166	2,154	2,393	2	1	7	90
26	84	..	45	1,161	1,290	7	..	3	90
8	275	118	200	4,488	5,081	5	2	4	88
21	11	26	42	1,307	1,386	1	2	3	94
9	763	..	57	4,969	5,789	13	..	1	86
31	50	..	20	478	548	9	..	4	87
28	167	552	132	432	1,283	13	43	10	34
24	206	45	156	1,927	2,334	9	2	7	83
25	96	18	79	1,327	1,520	6	1	5	87
36	23	..	9	108	140	16	..	6	77
13	353	1	2	1,906	2,262	16	[1]	[1]	84
14	20	513	147	2,209	2,889	1	18	5	76
Total	3,974	2,192	2,239	36,189	44,594	9	5	5	81

TWENTY-FIVE ESTABLISHMENTS IN DETROIT

22	55	..	25	898	978	6	..	3	92
24	365	..	45	1,464	1,874	19	..	2	78
10	94	..	137	809	1,040	9	..	13	78
35	43	27	15	482	567	8	5	3	85
27	63	24	67	912	1,066	6	2	6	86
18	113	..	130	1,190	1,433	8	..	9	83
11	747	242	317	4,489	5,795	13	4	5	77
30	137	..	68	694	899	15	..	8	77
41	120	..	30	273	423	28	..	7	65
25	168	..	84	1,805	2,057	8	..	4	88
13	116	306	63	1,638	2,123	5	14	3	77
29	102	250	53	290	695	15	36	8	42
32	18	..	22	344	384	5	..	6	90
39	52	260	42	183	537	10	48	8	34
40	148	32	64	369	613	24	5	10	60
3	5,115	3,799	2,727	34,167	45,808	11	8	6	75
1	169	110	3,122	11,230	14,631	1	1	21	77
9	965	1,879	362	3,581	6,787	14	28	5	53
2	4,886	2,085	2,304	20,916	30,191	16	7	8	69
16	112	..	95	924	1,131	10	..	8	82
28	51	26	106	450	633	8	4	17	71
26	66	37	89	318	510	13	7	17	62
38	13	20	13	95	141	9	14	9	67
36	15	3	20	68	106	14	3	19	64
8	548	4	.....	2,463	3,015	18	[1]	..	82
Total	14,281	9,104	10,000	90,052	123,437	11	7	8	73

[1]Less than 1 per cent.

employment department, maintain a trained employment executive or in any way give consideration to the workers. In the next largest turnover—359 per cent—which occurred in a storage battery plant employing 1610 daily, it was found that the general character of the work is disagreeable due to the use of odorous chemicals, fine powders and to conditions which of necessity are hot and dusty. The firm has a well organized employment department, but still allows time-keeping clerks and foremen the power of hiring and firing.

Firm No. 1, an automobile and motor truck manufacturer with a well balanced employment organization, where the power to hire and fire rests only with the highest labor executive and where sick benefits, insurance and other welfare schemes are practiced shows the lowest labor turnover—65 per cent per year. This concern employs 4456 daily.

Table 2 shows the extent of labor turnover in 42 Detroit establishments.

It will be noted that one concern has a turnover under 50 per cent, 3 under 100 per cent, 3 under 150 per cent, 3 under 200 per cent, 6 under 250 per cent, 8 under 300 per cent, 4 under 350 per cent, 5 under 400 per cent, 6 between 400 and 500 per cent, and 3 over 500 per cent.

Establishment No. 1, which is undoubtedly the Ford Motor Co., employing an average of 31,950 people daily, as is known, has a very comprehensive welfare scheme and treats its employees liberally and fairly. It will be noted that the Ford company discharges less than 1 per cent of the people leaving its employment each year—

Table 4—Number and Per Cent in Employ and Among the Separations of Specified Length-of-Service Groups of Employees in Each of 18 Establishments in Cleveland

NUMBER IN EACH CLASSIFIED SERVICE GROUP

Establishment Number	On Payroll at End of Year: One Week or Under	Over 1 Wk. to 2 Wks.	Over 2 Wks. to 1 Mo.	Over 1 Mo. to 3 Mos.	Over 3 Mos. to 6 Mos.	Over 6 Mos. to 1 Yr.	Over 1 Yr. to 2 Yrs.	Over 2 Yrs. to 3 Yrs.	Over 3 Yrs. to 5 Yrs.	Over 5 Yrs.	Total	Separated During the Year: One Week or Under	Over 1 Wk. to 2 Wks.	Over 2 Wks. to 1 Mo.	Over 1 Mo. to 3 Mos.	Over 3 Mos. to 6 Mos.	Over 6 Mos. to 1 Yr.	Over 1 Yr. to 2 Yrs.	Over 2 Yrs. to 3 Yrs.	Over 3 Yrs. to 5 Yrs.	Over 5 Yrs.	Total	Industry or Nature of Business
6	69	59	121	351	353	247	105	88	63	42	1,498	249	255	504	1,516	1,256	1,263	438	378	252	178	6,289	Automobile and motor truck mfg.
1	95	85	58	488	390	783	705	533	785	772	4,694	135	88	135	652	600	559	307	240	96	72	[1]2,884	Do.
32	21	23	22	35	32	44	36	10	16	21	260	173	45	69	72	40	30	12	....	1	1	443	Brushes mfg.
27	22	30	32	89	58	53	76	54	9	55	478	64	103	119	256	103	69	35	9	7	11	776	Electrical appliances mfg.
21	9	27	15	36	34	87	122	93	77	313	813	202	399	203	240	137	92	46	19	12	36	1,386	Metal products mfg.
19	66	50	78	130	87	166	128	127	31	162	1,025	390	434	414	603	268	181	61	19	7	16	2,393	Storage batteries.
15	27	36	117	217	130	233	174	148	132	138	1,352	259	252	349	536	301	220	77	54	9	9	[1]2,066	Metal products mfg.
26	7	7	33	50	21	58	88	26	18	244	552	221	146	203	216	107	106	65	9	16	24	[1]1,113	Do .
20	17	21	66	63	51	113	111	54	84	152	732	1,724	653	439	43	42	31	43	31	42	43	3,091	Malleable iron castings
37	5	4	9	10	10	13	16	7	13	5	92	36	9	20	21	20	20	11	2	....	..	139	Molding machinery mfg.
31	8	17	14	33	15	25	30	10	5	80	237	202	59	52	100	65	43	12	2	5	8	548	Paint and varnish mfg.
39[2]	....	2	9	12	8	3	13	6	6	23	82	4	6	5	14	6	12	7	3	2	1	60	Printing.
29	21	9	28	61	32	46	40	37	34	12	320	74	67	309	345	108	78	27	21	8	1	1,038	Street-railway cars mfg.
9	57	88	97	314	271	300	284	106	106	261	1,884	1,766	674	765	1,114	527	322	129	19	31	25	[1]5,372	Storage batteries, carbon products, mfg.
36	5	6	6	13	20	13	12	2	2	28	107	5	9	21	30	28	22	15	3	3	4	140	Telephone service (clerical force.)
31	85	50	45	212	183	345	425	145	181	163	1,834	291	208	201	378	354	349	221	79	116	63	[1]2,260	Telephone service (operating force).
14	24	12	35	109	133	192	107	34	64	167	877	426	249	463	823	499	255	95	27	22	30	2,889	Telephone service (plant).
10	60	49	111	158	91	260	193	86	87	598	1,693	897	388	585	947	484	331	162	28	40	168	4,030	Woodwork, sewing-machine cabinets, etc.
Total	598	575	896	2,381	1,919	2,981	2,665	1,566	1,713	3,236	18,530	7,118	4,044	4,856	7,906	4,945	3,983	1,763	943	669	690	36,917	

PER CENT IN EACH CLASSIFIED SERVICE GROUP

6	5	4	9	23	24	16	7	6	4	3	100	4	4	8	24	20	20	7	6	4	3	100	Automobile and motor truck mfg.
1	2	2	1	10	8	17	15	11	17	16	100	5	3	5	23	21	19	11	8	3	2	100	Do.
32	8	9	8	13	12	17	14	4	6	8	100	39	10	16	16	9	7	3	....	[3]	[3]	100	Brushes mfg.
27	5	6	7	19	12	11	16	11	2	12	100	8	13	15	33	13	9	5	1	1	1	100	Electrical appliances mfg.
21	1	3	2	4	4	11	15	11	9	38	100	15	29	15	17	10	7	3	1	1	3	100	Metal products mfg.
19	6	5	8	13	8	16	12	12	3	16	100	16	18	17	25	11	8	3	[3]	[3]	1	100	Storage batteries.
15	2	3	9	16	10	17	13	11	10	10	100	13	12	17	26	15	11	4	3	[3]	[3]	100	Metal products mfg.
26	1	1	6	9	4	11	16	5	3	44	100	20	13	18	19	10	10	6	1	1	2	100	Do.
20	2	3	9	9	7	15	15	7	11	21	100	56	21	14	1	1	1	1	1	1	1	100	Malleable iron castings
37	5	4	10	11	11	14	17	8	14	5	100	26	6	14	15	14	14	8	1	....	..	100	Molding machinery mfg.
31	3	7	6	14	6	11	13	4	2	34	100	37	11	9	18	12	8	2	[3]	1	1	100	Paint and varnish mfg.
39[2]	....	2	11	15	10	4	16	7	7	28	100	7	10	8	23	10	20	12	5	3	2	100	Printing
29	7	3	9	19	10	14	12	12	11	4	100	7	6	30	33	10	8	3	2	1	[3]	100	Street-railway cars mfg.
9	3	5	5	17	14	16	15	6	6	14	100	33	13	14	21	10	6	2	[3]	1	[3]	100	Storage batteries, carbon products, mfg.
36	5	6	6	12	19	12	11	2	2	26	100	4	6	15	21	20	16	11	2	2	3	100	Telephone service (clerical force).
13	5	3	2	12	10	19	23	8	10	9	100	13	9	9	17	16	15	10	3	5	3	100	Telephone service (operating force).
14	3	1	4	12	15	22	12	4	7	19	100	15	9	16	28	17	9	3	1	1	.1	100	Telephone service (plant).
10	4	3	7	9	5	15	11	5	5	35	100	22	10	15	23	12	8	4	1	1	4	100	Woodwork, sewing-machine cabinets, etc.
Total	3	3	5	13	10	16	14	9	9	18	100	19	11	13	21	13	11	5	3	2	2	100	

[1]Period covered by separations is different from period covered in Table 1.
[2]This establishment lacked the data for Table 2.
[3]Less than 1 per cent.

169 having been discharged in the 12 months. Establishment No. 6, coke manufacturers, despite the unpleasantness and hazardous nature of the work, maintains a turnover of only 86 per cent a year. This record is the result of a carefully worked out liberal labor policy, the existence of an efficient employment department and the centralization of all functions relating to employment, promotion and service. More than 60 per cent of the employees earn $1,300 annually, ad less than 10 per cent less than $1,200. The firm maintains a medical staff, operates an employees' sick benefit and conducts a co-operative store. Workers with continuous service records are given bonuses. A profit-sharing plan allows for distribution of certain profits each year in proportion to the salaries. Filtered drinking water, lockers and showers, special shaving conveniences, em-employees' lunch room, club rooms, and a special housing plan are maintained.

Establishment No. 40, an automobile car and parts maker, pays no attention to his labor organization, allows foremen to hire and fire, and—the labor turnover is 507 per cent annually.

Nine per cent of the workers in Cleveland and 11 per cent in Detroit were found to have been discharged during the year, 5 per cent and 7 per cent respectively were lost in temporary lay-offs, 5 per cent and 8 per cent entered military service and 81 per cent in Cleveland and 73 per cent in Detroit quit their jobs, which indicates definitely that it is the restlessness of the worker or the offer of better wages or other similar inducements that cause the chief proportion of turnover.

Table 3 shows specifically the number and percent of separations and the causes.

The length of service, which was discussed in the opening paragraph of this article, is shown in tables 4 and 5. (*Continued on page* 667)

Factors in High-Speed Engine Development

Forced Lubrication — High Mean Effective Pressure — Valve Areas—Inertia Problems—Valve Timing and Materials—Piston Material and Design, All Play Important Roles

D. McCall White Favors Cast Iron Pistons—Tells S. A. E. the Story of Cadillac Engine Development

Part I

By D. McCall White*

DIFFERENT firms have different ideas regarding engines of high efficiency and moderately efficient engines. For very high-speed engines, the designer must not lose sight of the fact that what the public requires to-day is a small engine which has good torque at low speeds and is capable of revolving efficiently at very high speeds.

These two points are difficult enough to attain together, as one is really opposed to the other in practice, due to the fact that in order to obtain high speeds with power, the valve areas, valve ports, carbureters, etc., must not be restricted in any way whatever; whilst, in order to obtain a good mixture at low speeds with heavy torque, means, firstly, a different valve setting and, secondly, more or less restricted port and valve areas, etc., in order to give high gas velocities.

If one adds to the above complications the fact that it is also required that the modern valve gear must be silent, the proposition is one which calls for considerable thought and ingenuity.

Briefly stated the fundamentals of high-speed engines are as follows:

High mean effective pressures at high speeds which depends on:

1—High volumetric efficiency.

2—High compression to help rapid combustion at high speeds.

3—Light reciprocating and rotating parts to obtain high mechanical efficiency.

It is only a few years ago since engines were designed with a maximum power of 1200 to 1500 r.p.m., although other designers had the forethought to consider that it was possible to attain very high engine speeds indeed, and to-day this is an accomplished fact.

The high-speed, high-efficiency engine of to-day must be designed very carefully in order to obtain good results, as one slip will spoil the whole design. We have all lengths of stroke-bore ratios, but the stroke-bore ratio should be from 1.5 to 1 to 1.625 to 1, because one can obtain all the power required without having a very unwieldy and heavy engine.

It should also be considered that there are more fastidious purchasers than ever to-day who buy cars, and therefore there must be no doubt whatever that the engine must be practically free from vibration and must be most sweet, silky and silent when transmitting power. In short, the salable article is the one which has small size coupled with great power and is neat and compact in design, with the requisite silence. There is nothing pleases the owner more than to have these combinations.

I believe I have mentioned many times that a bore of about 90 millimeters is about the maximum cylinder for high-speed work, and after that I certainly believe multiplicity of cylinders should commence.

Mean Effective Pressures

It is quite useless to think of designing an engine to cope with the present-day market unless it can develop power up to from 2500 to 3500 r.p.m. or over, smoothly and quietly. The power must be good and a touring engine of to-day must be capable of carrying a mean effective pressure from 80 to 100 lb. per sq. in., relative to the brake horsepower up to 2200 r.p.m. at least.

A power and mean effective pressure curve might be of interest—Fig. O. The curve shows the mean effective pressure and b.hp. on a 12-horsepower Napier engine designed around 1911 having one L head exhaust valve and

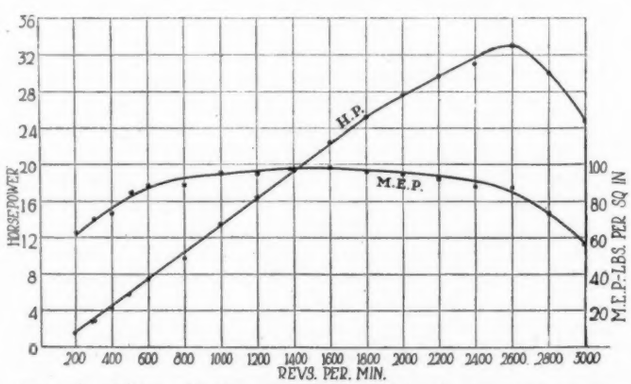

Fig. O—Mean effective pressure and brake horsepower on 12-hp. Napier four-cylinder engine, 2 11/16 by 5

*EDITOR'S NOTE—D. McCall White, vice-president of the Cadillac Motor Car Co., read this paper before the mid-winter meeting of the Society of Automotive Engineers in New York, February, 1919. Mr. White designed the Cadillac eight-cylinder engine, which was the pioneer in high-speed, multiple-cylinder engines in America. Previous to coming to America he was engineer with two or three leading European car makers.

one overhead intake valve immediately above. This engine was a four-cylinder, 2 11/16 by 5 in., and showed a mean effective pressure relative to the brake of 98 lbs. per sq. in., and a maximum power of 33 B. H. P. at 2600 r.p.m. The engine was fitted with a muffler but pulled more power, naturally, without the muffler and had a two-jet carbureter of my own design. The crankshaft had two bearings and had forced lubrication oiling system throughout.

A curve, Fig. 1, shows mean effective pressure and power curve of the standard Cadillac eight-cylinder engine run up to very high speeds of 3750 r.p.m., which is of considerable interest.

Relative to mean effective pressures the table below shows bore and stroke with revolutions per minute and mean effective pressures relative to the brake, which I obtained from seven different engines some few years ago:

Bore, m/.	Stroke, . /m	M. E. P. R. P. M. Lbs. per Sq. In.	
68	127	2400	89
68	127	2000	97.5
82.5	127	1200	82.5
89	127	1200	79.5
96	130	1200	127
80	130	3000	103
80	130	2400	104

Volumetric Efficiency

To design a successful high-speed engine, it is desirable that the compression should be fairly high in order to get rapid combustion at high speeds, and the ratio should approximate 21 per cent of the total volume. A compression curve, Fig. 2, shows how the compression is maintained in the Cadillac eight-cylinder engine.

Whilst on the subject of compression, a very simple and easy method of indicating the compression on the engine, as well as the maximum pressure, can be accomplished by the Okill indicator, an English instrument, and which we have found to be very satisfactory. Fig. 1-B shows this instrument attached to a Cadillac eight and it is easy to see the graduations on the outside cylinder of the instrument. This instrument consists of a cylinder containing a piston of about ½-in. diameter, the piston being held at the bottom of a cylinder by a coil spring.

The cylinder is screwed into a fitting which communicates by a small passage with the combustion chamber and a stop-cock is placed in the passage. The tension of the spring holding the piston on its seat can be varied by a knurled nut at the top of the cylinder, the motion of the piston being transmitted to a pointer at the side of the cylinder. When using this, the knurled nut is screwed down until a considerable pressure is put on the piston, the stop-cock being then opened and the knurled nut backed off until the piston just starts to lift each time the engine comes up on the compression stroke, thus indicating that the spring pressure just balances the compression.

The tension of the spring and consequently the compression indicated, is directly proportional to the number of turns required on the adjusting nut, and the motion of the nut is indicated in the same manner as the motion of the barrel of the ordinary micrometer, except that it is graduated to read in lbs. per sq. in.

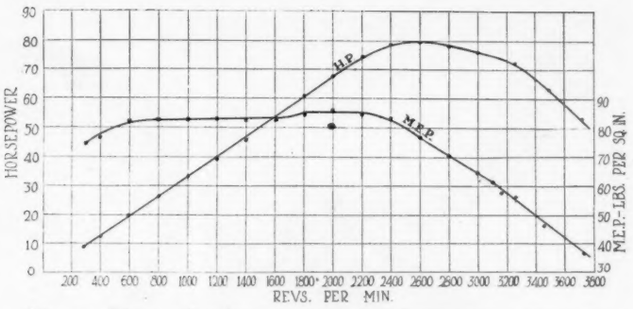

Fig. 1—Mean effective pressure and horsepower curve on Cadillac eight up to 3750 r p m.

High-Speed Characteristics

The high-speed engine might be likened to an air compressor, as the great point is to get the charge into the cylinders and thus obtain the highest possible volumetric efficiency, and much can be done by the shape of pipes, smoothness of same, lack of bends or elbows, particularly careful design of valve ports, seats, etc., together with the cooling of same.

The volumetric efficiency is entirely dependent upon port area, large carbureters, large valves, etc., but coupled with these advantages is the obvious disadvantage of carburetion and starting in cold weather, which former affects the acceleration to a very great degree. As cold weather is with us every year, it is highly important that precautions should be taken by the designers to see that their enthusiasm for maximum power does not overstep the bounds of proper carbureter size, etc. in order to get a combination of highly satisfactory running, both summer and winter.

A great deal has been done in heating intake manifolds and I propose to deal with this point later. The curve, Fig. 1-A, illustrates the difference on Cadillac eight-cylinder engine in 1915 when using 1¼-in intake manifold as against 1½-in. intake manifold. It will be noted that the power is increased right up the line from 1200 r.p.m. and was about the same at lower speeds.

On the matter of high volumetric efficiency, we have heard a great deal on the question of multiple valves and I do not know whether it is generally known that multiple inlet valves consisting of a group of three intake valves were used in the English Napier car in 1909.

A great deal has been heard of the overhead valve and many types of overhead valve systems have been used. We have seen racing cars with overhead camshafts driven by bevel gears, spur gears, spiral gears, etc.; other valve systems with the camshaft below and push rods with rockers operating the valves above.

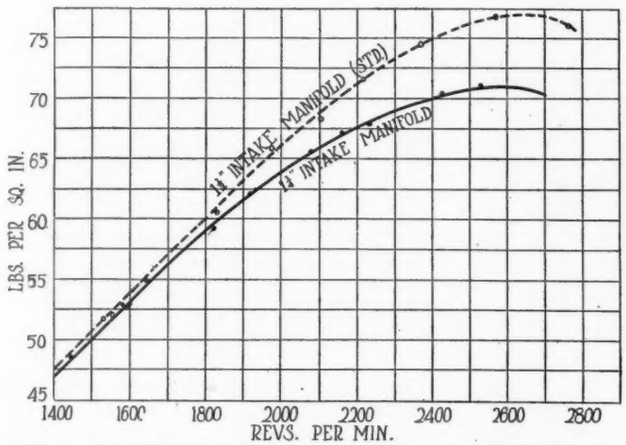

Fig. 1A—Difference in horsepower using 1½-in. manifold as compared with 1¼-in. size on 1915 Cadillac eight

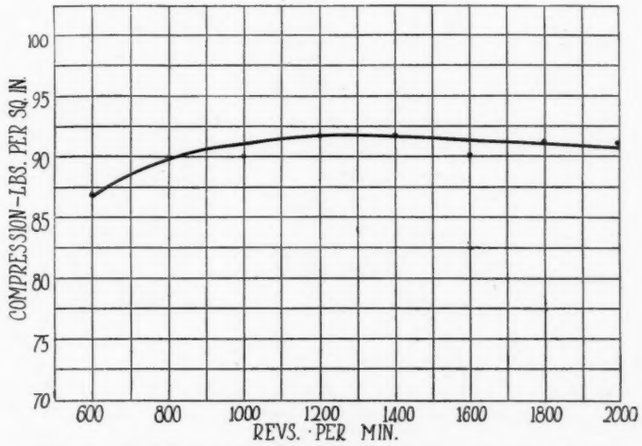

Fig. 2—Cadillac eight-cylinder engine compression curve up to 2000 r.p.m.

Fig. 1B—The O'Kill pressure indicator for engine tests

The Wimperis accelerometer used in road testing

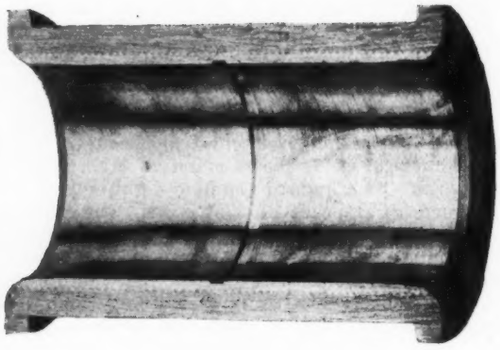

Fig. 8—Circular oil groove in the center of the bearing which serves as an oil reservoir

Much can be said regarding the different types, but I do not believe that it is possible to design a satisfactory and quiet overhead valve mechanism with a combination of rocker arms and overhead camshafts, because of the difficulty in obtaining quiet engines. On the other hand we have a quieter system having the camshaft below and push rods coupled with rocker arms operating the valves above, but I believe that the inertia of this valve mechanism would be so great as to almost put it out of count as the kind of a valve gear which should be designed into a high-speed engine.

Valve Gear Types

When all is said and done, there is a great deal to be said for the L-head type of engine, because the valve gear can be kept down very light indeed, very good sized valves can be used and it is a fact that this, up until the moment, is the quietest type of valve gear which can be used in the touring car engine. It is true that the engine fitted with overhead valves when properly designed should pass approximately 25 per cent more gas than the L-head engine, although a well designed L-head engine uses about 75 per cent of the circumference of the valve, whilst with the T-head engine only about 50 per cent of the circumference of the valve is effective. Where multiple valves are used, it is very easy to see by simple calculation that the frictional resistance offered by double valves and ports is approximately 30 to 35 per cent greater than that of a single valve and port of the same area.

On the question of the inertia of valve mechanism generally, in the Cadillac eight we are obtaining engine speeds on the road of well over 3000 r.p.m. and have records of 3550 and 3850 r.p.m. road performance. If one considers, referring to the valve mechanism, just exactly what this means on the matter of acceleration, which information can easily be obtained by simple figuring, that at 3000 r.p.m. the time taken to open and close one of the valves is .0125 second, at 3550 r.p.m. the time taken to open and close one of the valves is .0106 second, and at 3850 r.p.m. the time taken to open and close one of the valves is .0098 second. You will see, therefore, that the first thing a valve has to do, in a very high-speed engine, after it opens, is to close, and there is mighty little time allowed to do that.

Valve Seat Angles

At various times there have been discussions regarding the different angles for valve seats, and if one takes a seat of 50 degree angle having a supposed lift of ¼ in., this will give a valve area across the narrowest portion of only 72 per cent of ¼ in.; whilst if the valve seat having the same width of seat as the 50 degree seat is 30 degrees, this gives 87.5 per cent of ¼ in.; whilst the 30 degree seat narrowed down to around 1/16 in. gives the same amount of ¼ in., but, of course, gives a larger valve bore, thus decreasing the velocity through the bore itself.

Valve Timing Results

The valve timing of an engine has quite some considerable effect on the power, not only at low speeds, but at high speeds. We ran some power curves on the Cadillac 1916 eight at that time, all of these tests being run on the same engine,

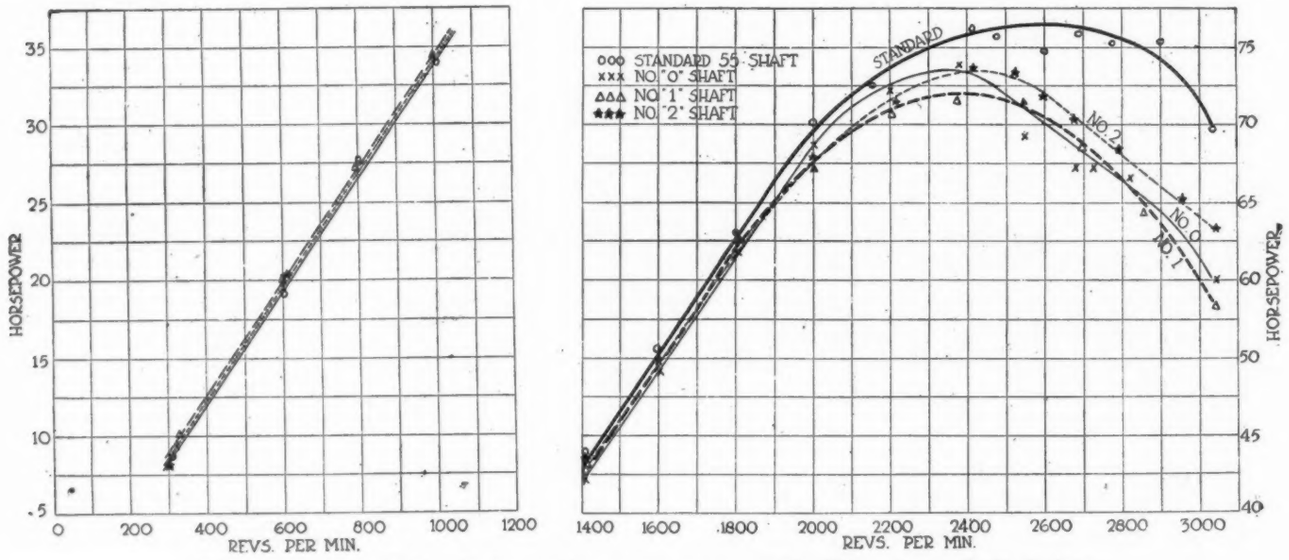

Fig. 3—Cadillac eight-cylinder engine power curves with different camshaft designs

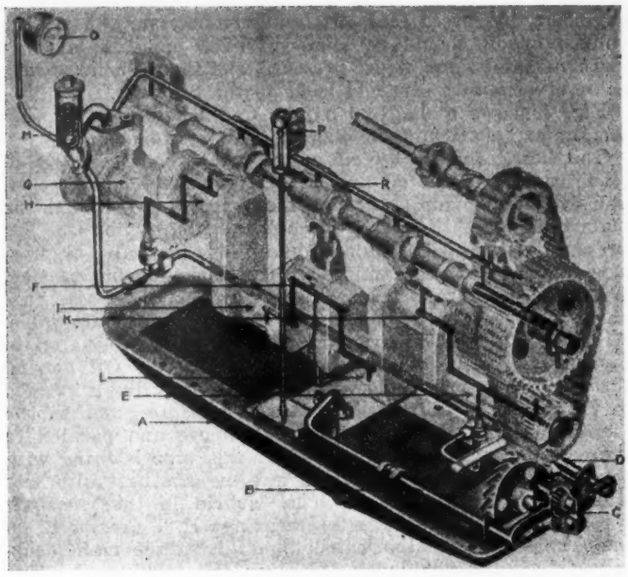

Fig. 7—Cadillac forced feed oiling system

and superimposed curves are shown in Fig. 3. Chart No. 1, which is known as Standard, is the following timing:

	Inlet Opens	Inlet Closes	Exhaust Opens	Exhaust Closes
Standard timing	3° 49′ (A)	47° 29′ (A)	46° 56′ (B)	3° 7′ (A)
No. 0 timing.....	1° 52′ (A)	31° 22′ (A)	47° 52′ (B)	1° 49′ (A)
No. 1 timing.....	2° — (B)	32° 19′ (A)	47° — (B)	1° 10′ (A)
No. 2 timing.....	1° 22′ (A)	33° 7′ (A)	43° 31′ (B)	2° — (A)

Under Fig. 3 is shown horsepower curves superimposed on one another, all of which are self-explanatory, and inspection will show a slight gain in power up to 1000 r.p.m. in favor of the shafts marked No. 0, No. 1 and No. 2, but after that point there is a slow and steady loss up to 2400 r.p.m., where there is a sudden break in the curves, whilst the curve run with the Standard timing shows practically no loss of power up to and around 2800 r.p.m.

Valve Material Specifications

In my opinion, the material used in valves is very important. In England around 1913 when running with engines turning up as high as 300 r.p.m., I used a material in the valves having the following analysis:

	Per Cent
Carbon	0.40
Silicon	0.14
Sulphur	0.03
Phosphorus	0.035
Manganese	0.65
Nickel	5.00

whilst for engines running around 3000 r.p.m. the following anaylsis was used:

	Per Cent
Carbon	0.32
Silicon	0.10
Sulphur	0.03
Phosphorus	0.037
Nickel	3.00

Whilst both these analyses were satisfactory, we always had more or less trouble with valves warping and consequent compression leakage. The analysis of the valves used in the Cadillac eight-cylinder engine should be of interest, as we practically do not know what trouble is, so far as our valves are concerned.

For the intake valves the following analysis is used:

	Per Cent
Carbon	0.69
Manganese	0.32
Sulphur	0.012
Chromium	1.08
Tungsten	2.15
Vanadium	0.08
Silicon	0.15
Nickel	0.15

whilst the exhaust valves have the following analysis:

	Per Cent
Carbon	0.56
Manganese	0.35
Sulphur	0.016
Nickel	0.12
Chromium	3.06
Tungsten	13.84
Silicon	0.17

I have already laid considerable stress on the weight of the valve mechanism, and it is well known that the pistons

Fig. 4—Aluminum piston after 50-hr. test in Liberty engine, corroded due to changing quality of mixture and intense changes of temperature

Fig. 5—A Cadillac piston that had not enough surface above the wrist pin and below the bottom groove

Fig. 6—Standard piston and connecting-rod on Cadillac eight engine

should be just as light as ever possible. I have tried various designs of pistons, including aluminum, steel and cast iron of all different shapes, and up until the moment of writing, so far as the touring car engine is concerned, I have not found either the aluminum or steel pistons to be satisfactory.

In the first place, it is necessary to give both the aluminum and steel pistons very much too great clearances in order to insure quiet running and satisfactory performance of the motor. Where aircraft engines or engines which are continually running at high speeds are concerned, it is possible so far as clearances are concerned that the aluminum pistons are entirely satisfactory, but there is no doubt in my mind that owing to the intense changes of temperature in any motor that the aluminum pistons are apt to be eaten away in very little time.

Fig. 4 illustrates an aluminum piston taken after a 50-hour test on a Liberty twelve, which is considerably corroded and is merely an example of continuous changing of temperature or quality of mixture and its effect on aluminum alloy.

Fig. 5 shows the lightest form of cast iron piston which I have been able to develop up to date, the weight of same being 15 ounces and the diameter being 3⅛ in. The surface above the wrist pin and below the bottom groove was insufficient and the piston wore rapidly at that point.

Fig. 6 shows assembly of Cadillac standard pistons and connecting rods.

Before leaving the pistons, let me mention that in multiple-cylinder, high-speed engines with relatively small bores and large superficial area of combustion chamber walls, it is highly important to prevent the water, which is ever present at combustion, and gasoline, when an enriching carbureter device is used for starting in cold weather, from getting past the pistons into the crankcase, thereby causing stoppage of lubrication by the water becoming frozen, corrosion of parts such as ball bearings, distributer breaker points, where this essential is designed into the engine, crankpin journals and main shaft bearings. This menace cannot be too seriously considered and the only remedy is the accuracy of piston and cylinder fits and proper piston lubrication, all of which goes hand in hand with cast iron pistons in cast iron cylinders. Later on in the paper is given a table of piston clearances which will be of interest also relative to the above points.

Forced Lubrication Essential

I believe it is a well known fact that high speeds or continued speeds under high power cannot be maintained satisfactorily without the use of forced lubrication. One example which we had before us not so very long since was in connection with the Liberty engine, where attempt had been made to feed the connecting rod crankpin end bearings by means of oil thrown from the main bearings. This proved entirely unsatisfactory after tests carried out by Messrs. H. M. Crane of the Wright-Martin Aircraft Corp., John Wilkinson of the H. H. Franklin Mfg. Co. and myself, and was substituted, in agreement with the Government engineers, by forced feed. It is highly necessary that large volume of oil should be pumped under pressure and not merely small volume under pressure, and there should always be reservoirs with separate leads to the bearings.

Fig. 7 shows a diagram of the Cadillac lubricating system, an explanation of the diagram being as follows:

The lubrication is by oil under pressure. A supply of oil is carried in the oil pan A. Oil is drawn from the oil pan by the oil pump C through the pipe B and forced to the main bearings E, F and G, through the supply pipe D. The pressure of the oil is regulated by an overflow valve or pressure regulator M containing a valve under spring tension. When the pressure is reached for which the valve is set, the valve is forced open and the oil overflows past the valve. A small hole drilled in the regulator housing allows oil to by-pass the valve when the valve is seated. Oil flowing through the by-pass and oil forced past the valve is carried to the camshaft bearings and power pressure pump in the gasoline system through the pipe R above and parallel to the camshaft. The forward end of this pipe is fitted with two nozzles from which oil flows into the camshaft sprockets and to the chains through holes drilled in the camshaft sprockets. The connecting rod bearings H, I, K and L, on the crankshaft, are lubricated by oil from the main bearings forced through holes drilled in the crankshaft. The hole is drilled in the crankshaft sprocket through which oil is supplied to the camshaft chain. The cylinders are lubricated by oil thrown from the lower ends of the connecting rods. There is one gauge and one indicator in the lubricating system. The pressure gauge O is located on the instrument board and indicates the pressure of the oil. The indicator P is attached to the upper cover of the crankcase near the carbureter and indicates the level of the oil in the oil pan A.

The Bellis high-speed, double-acting, steam engine, in which design was first incorporated the forced lubrication system, is described by Prof. Ripper in his book Steam Engine Theory and Practice as follows: "The Bellis engine will illustrate the possibility of running double-acting engines at high rotational speed without fear of excessive wear and knocking. It is claimed for it that its success is generally due to the application of forced lubrication, that is, supplying the lubrication to the moving parts under pressure. The pressure required for this proposition is not the maximum pressure on the bearings, but only a pressure sufficient to force the oil into the bearings on the return stroke, when the pressure is reduced on one side of the pin, while on the driving stroke the time is not sufficient to squeeze the oil between the surfaces before the pressure is again reduced and the supply renewed. The difficulty felt in running double-acting engines at high rotational speeds arises from the known necessity of close adjustment of the bearings to avoid audible knock and insure quiet running, and this necessary closeness of adjustment renders the pin and its bearing very liable to get hot and the pin to seize. This liability to seize arises from the fact that, owing to the necessary closeness of fit, any small increase of temperature in the pin causes sufficient expansion to make it overtake the small clearance permissible when cold, and trouble immediately follows from

Table No. 1

Cast-Iron Pistons Without Extra Oil Supply

R. P. M.	300	600	800	1000	1200	1400	1600	1800	2000	2200	2400	2500
						Brake horsepower						
Clearance 0.002 in	3.4	9.3	12.2	15.5	18.7	20.7	22.4	23.2	23.2	19.4	18	17.4
Clearance 0.004 in	3.7	8.8	12.8	15.9	18.9	21.6	22.8	23.4	22.6	23.4	21.3	20.2
Clearance 0.006 in	4.4	9.5	13.1	16.5	19.4	22.2	23.2	24	24	24	20.2	20.9
Clearance 0.008 in	4.2	9.7	13.2	16.5	19.1	22.2	24.8	25.1	23.9	22.4	20.6	19.5
Aluminum Pistons Without Extra Oil Supply												
Clearance 0.013 in	4.05	9.2	12	15.2	18.2	21	21	22	20	17.5	15.6	15.2
Clearance 0.016 in	3.6	8.5	12.1	15.1	18.7	20.7	22.7	25.3	25.2	24.5	21.4	21

Table No. 2

Cast-Iron Pistons With Extra Oil Supply

R. P. M.	300	600	800	1000	1200	1400	1600	1800	2000	2200	2400	2500
						Brake horsepower						
Clearance 0.002 in	4.4	9.9	13.1	17.2	20.4	22	23.9	25.2	25.4	24.4	21	20.6
Clearance 0.004 in	4.3	9.5	13.8	17.7	21	24	25.4	25.6	27	25.6	26.4	25
Clearance 0.006 in	4.8	10.3	14.2	17.6	21.2	24.2	25.8	27.2	28	27	27	24.6
Clearance 0.008 in	4.7	10.3	14.5	17.7	21	24	25.9	26.9	27.9	27.2	27	24.6
Aluminum Pistons With Extra Oil Supply												
Clearance 0.013 in	4.7	10.3	14	17.5	21	24	25.6	26.3	26.6	27.2	26.6	25.4
Clearance 0.016 in	4.7	10.3	13.3	16.8	20.2	23.6	25.8	27.2	27.3	27.8	26.6	24.6

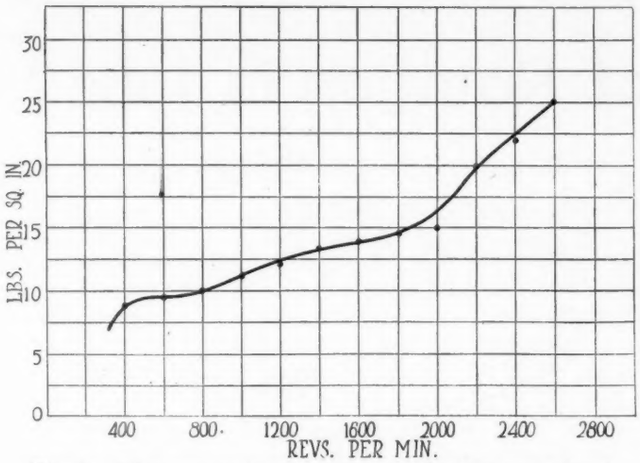

Fig. 9—Oil pressure in relation to revolutions per minute

seizure of the pin. There cannot, however, be any increase of temperature in the pin so long as the pin and its bearing are well supplied with oil between the surfaces—hence the value of forced lubrication."

Particular points in connection with forced lubrication are as follows: Saving in friction which occurs with forced lubrication. Tests were made with oil pressures of varying loads and it was found that the engine was quieter the higher the pressure and the frictional horsepower was, with high oil pressure, only 60 per cent of that without pressure, and 72 per cent with medium pressure of that without pressure.

Results of Bearing Tests

It is interesting to note that we have carried out some very extensive tests on the Cadillac engine at high speeds and have been able to maintain power for periods extending over 400 hours at 2000 r.p.m. without adjusting the bearings. In addition to this we have been able to maintain maximum power at 3000 r.p.m. for 12 hours without stopping, which I consider a triumph for forced lubrication.

Some years ago I carried out some tests having different clearances of pistons, both cast iron and aluminum, with and without extra oil supply to the pistons, and table No. 1 indicates the power developed without extra oil supply, whilst table No. 2 indicates the power developed with extra oil supply. The diameter of pistons was 3¼ in. and the tables themselves are self explanatory as to the results obtained.

On the matter of oil grooves, these should be conspicuous

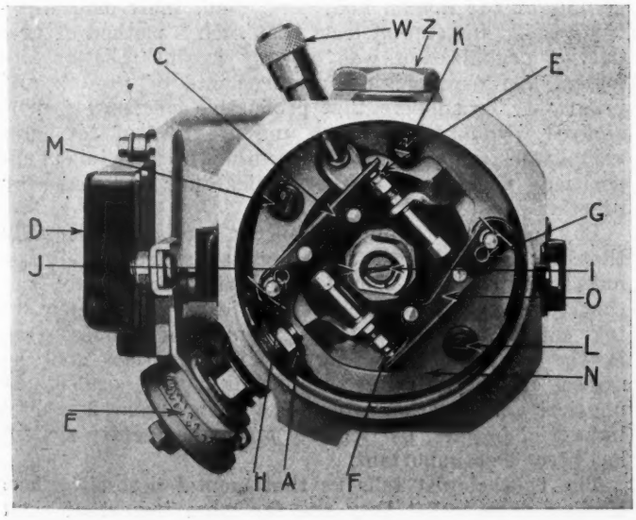

Fig. 10—Cadillac ignition with two sets of contacts arranged to fire alternately

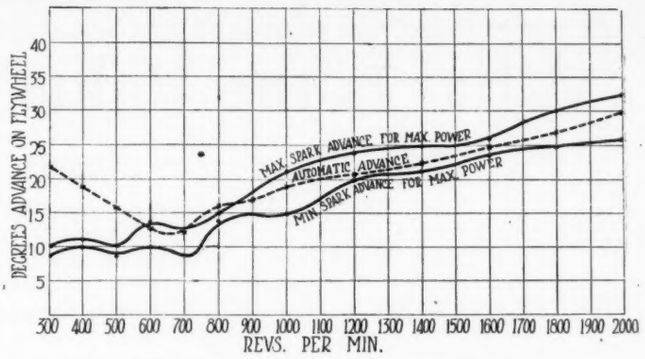

Fig. 11—Curves showing degree of spark advance on the flywheel relative to r.p.m.

by their absence so far as what is known as the ordinary kind of groove is concerned, the only type of groove which I would favor being one which is merely a circular groove around the center of the bearings, which is actually a reservoir and tends to have the oil right around the circumference of the bearing so that it can reach every part of it. Fig. 8 shows a Cadillac bearing with the groove described.

It is important that the oil pressure should be low when throttling, increasing as the speed increases, a system which I have found to be very satisfactory and which is incorporated in the Cadillac engine, a curve Fig. 9 illustrating oil pressure and r. p. m. which is self explanatory.

Ignition Developments

The most important factor in high-speed ignition is the time factor to energize the induction coil. To compensate for this, it is necessary to increase the flow of current or lower resistance in the primary circuit, and in doing this there is excessive sparking at low speed which oxidizes contacts and increases resistance, making it necessary to clean contacts at very short intervals somewhere varying from 1000 and 6000 miles. Duration of contact being very small due to the enormous number of sparks per second, agitated by oxidization, makes one set of contacts unsatisfactory when compared with the life of a well designed multi-cylinder, high-speed engine.

In view of this, therefore, around the beginning of 1915, my company started on three engines a continuous endurance run in order to see which part of the engine would wear out first. This endurance run was proposed to have a duration of 300 hours continuous running, and we found that it was impossible to run more than 13 hours at 2000 r.p.m. with the ordinary single arm breaker on the first type of eight-cylinder Cadillac engine. To overcome these serious objections, we built a distributer having two sets of contacts in parallel, or both closing and opening primary circuit simultaneously, each set carrying half the current, thereby reducing the arcing at the contacts to a minimum. Due to the tremendous inertia at high speeds, the contacts when closing are inclined to chatter, which causes the condenser to have a tendency to discharge, which in turn causes the arcing. This trouble is reduced to a minimum with two sets, as they do not chatter in synchronism and the adjustment of the two sets of contacts in parallel is not delicate, because in initial adjustment one set opens late and all arcing takes place on this one, causing it to waste away until it is in step with the one that opens first, so that they automatically come in step with each other. This arrangement makes it possible to operate an engine at a higher speed than any other arrangement at present developed, because it increases the time to build up the induction coil by decreasing the resistance.

After the above mentioned test, we were able to increase the speed of our engine up to 4000 r.p.m., which means 266 sparks per second, and after the installation of the two contacts in parallel, we were able to run 400 hours test without any ignition trouble, outside of occasional change in spark plugs.

(*Continued on page* 667)

What Is the Value of Rotation in Jobs?

Does Employer or Employee Benefit Most From Shifting Workers Frequently—or by Keeping Them Always at the Same Work?

By Harry Tipper

THE continual discussions which occur in regard to the increase of efficiency in production include, as a rule, statements concerning the necessity of increasing the efficiency of the human element, labor. It is not at all apparent from these discussions, however, that the same consideration has been given to the elements of human efficiency and the factors which must be taken into account in order to produce that.

It is true that a good many manufacturers have agitated for changes in the educational process in the schools and have instituted training schools in their own establishments for the purpose of securing a higher degree of skill from the workers, but these items merely indicate the general dissatisfaction with the present condition. They do not show that there has been any attempt to study the situation thoroughly, to make experiments in connection with it, in order to determine to what extent our present method of operation is based upon the proper conception of human interests, and to what extent it fails to take them into account.

The Human Element in Industry

The whole question of productive efficiency is concerned so intimately with that of education, the predisposition due to national tradition and social surroundings and political necessities, that it is hardly possible to consider efficiency from a manufacturing standpoint without, at least, understanding the deficiencies and tendencies of the rest of the worker's life. Even in respect to industrial surroundings it does not appear that we have studied the necessities of the case very seriously, and it is evident that we have concerned ourselves with the machine as the important factor in production, considering the human element as secondary and only to be regarded in order that the machine can fulfill its functions.

So long as we consider the human element secondary to mechanical equipment and only to be examined in relation to the machine, it is obvious that we shall not be able to determine the elements which enter into human efficiency from a productive standpoint correctly, and the discussions upon this matter must continue to be futile if not frivolous.

Specialization the Result of Factory System

In the growth of the factory system, with its machines constantly becoming more and more skillful and absorbing a larger proportion of the mechanical work of production, it was convenient to develop the worker for one particular piece of work. This method of operation required less supervision, that is, less intelligent supervision, and less preparation for manufacturing. It made it very much easier to train workers so that they arrived rapidly at a state of efficiency and it simplified the organization question. Some of these very advantages, however, were, in the nature of things, of negative value from the standpoint of human efficiency, and in some cases they were factors which actually reduced the capacity of the man.

Yet the system itself has not been questioned up to the present, and there is record of only one experiment in organization from a productive standpoint in an industry controlled by machinery. Discussion of the advisability of this system among engineers and manufacturers is fruitless, and this in itself is a symptom of the lack of study of the human element in production and, consequently, the almost total lack of understanding as to its requirements.

How do we know that one man, working on a gang of automatic screw machines for fifteen years, because his first training enabled him to be proficient in that work, can handle those machines to greater advantage than the man who has passed through a machine shop and knows the relative value of different machine operations and the relative proficiency required? How do we know that the skill of the fingers, and the co-ordination of the hand and the brain, are greater when the same operations must be performed by that co-ordination day in and day out for a number of years than where these operations are varied frequently.

The matter does not seem to have been discussed at all, but in view of the known variety of human interest, the known character of human aspirations and the recorded conditions of human production for the most part of its history, the practice is certainly open to question, and the assumed necessity a mere assumption of no greater value than that which attaches to a very brief tradition.

Psychology Shows Need of Variety

If the physiologist and the psychologist have secured any information in their scientific researches into the actions of the human body and mind, their determinations would indicate at least that such a method of productive organization was directly against the physiological and psychological requirements of growth and progress. To suppose that productive efficiency can be secured without the growth and progress of the individual worker, physically and mentally, is to indulge suppositions which are neither logical nor supported by practice.

Physiologists attempt to impress upon us continually that for good health and physical efficiency all the muscles of the body should be exercised reasonably, and that there should be a variety of exercise sufficient to take care of these necessities. The lack of balance—that is, the continual exercising of a few muscles and the neglect of others—is responsible for a great deal of the physical deterioration which has been observed among industrial peoples, particularly since the factory system has become so important.

The psychologist tells us that mental necessities are similar, except that they are far more important than physical necessities, because quickness of apprehension, understanding and mental sensitiveness, or the lack of

these qualities, influence the productive capacity, and also the point of view on all questions involved in social and economic life in an industrial country. The balance of mind and breadth of view are more important than any physical balance, necessary as that may be.

Some of the War's Lessons in Efficiency

During the war we have been taught some lessons upon efficiency in production which should indicate to us the necessity for fresh experimentation and for a deeper examination into our industrial organization, with the idea of discovering in what directions the present organization is weak and does not fulfill the requirements.

On the same machines with the same speed the incentive of patriotism expended in relation to the job improved production from 75 to 200 per cent in certain cases and improved it from 50 per cent in many other cases.

In the last few months a factory in England in the automotive field changed its procedure so that instead of holding a skilled mechanic to one job, his work is varied. The man who has been operating milling machines to-day may be assembling cars or motors next week, and contrary to all the traditional ideas upon this subject, this factory increased its production by three chassis a day with the same number of men, under the new system.

No man who has charge of supervision on any manufacturing work but has rebelled from time to time against the necessity of routine, the things which must be done each day in the same way. We strive to secure in all the other relations of life that variety which constantly keeps the intellect alive and quickens the apprehension by maintaining interest. Why, then, should it be supposed that there is greater efficiency to be secured by going contrary to this deep-seated human desire for variety of occupation and variety of interest?

Just because we accepted the tradition which began as a manufacturing convenience, and continued because there was no immediate problem to be faced, we have not thought it worth while to question the value of this tradition or to experiment with it to find out its necessity.

Routine Lessens Interest

The matter goes deeper than this, however, for where the routine has become so familiar that it has become subconscious, lack of interest follows as a logical consequence, and the possible efficiency is impaired by this lack of interest. Every manufacturer has noted the increase in productive capacity of the average individual under the stimulation of a new interest or the requirements of an emergency.

This productive capacity is not beyond ordinary possibility of the average human being, but there is no incentive to transfer to his regular work the energy which he has been willing to put forth under the stimulation secured from these causes. This extra effort, this unused or potential capacity, has shown itself of great importance during the war period, when it was stimulated into activity by the requirements of the war emergency and the demands of patriotism.

The question considered in this article is not provision of the incentive, which has been spoken about in previous articles and which relates to the responsibility of the worker in relation to the industrial organization of which he is a part, but it is a question of the reason for and the advisability of continuing the present type of industrial organization which trains a man for one piece of work and then keeps him at it continually without change.

The supposition that this method is necessary to secure the highest output per unit of cost is at present purely an assertion. No comparisons have been made with any other form of organization or with any other idea of production. It is not, however, in accordance with the known requirements of the individual in connection with his mental and physical growth, and it is not sufficient, therefore, to justify this organization by long and continued use nor to suppose it necessary because of the machine equipment.

It is obvious, of course, that the man who is working in a machine shop, running a milling machine, would be of no value running a loom. Neither would such a change increase his mental capacity in relation to his work. But there are good reasons for supposing the man who was grinding crankshafts to-day and fitting these crankshafts into the motor to-morrow, by grasping the importance of the previous piece of work and its relation to the motor efficiency, would be provided with an interest and an incentive in each piece of work that would not obtain to either by itself.

Whatever form of organization should be used from a production standpoint, it is obvious that the war has given us a glimmering of the importance of the human factor, that we are just beginning to understand the importance of the worker individually and as an organization, and it is being borne in on us that the present industrial system has not justified itself to the worker or to the general public.

This should encourage us to a new and deeper analysis of the human side of the case, to experimentation in production changes, especially those which involve the incentive and the interest of the worker, and above all, the rejection of all traditions and traditional forms of organization which cannot justify themselves except by tradition, so that we can either determine in how far they are valuable or sufficiently analyze them to be able to undertake changes that would make them valuable.

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Make Them Property Owners

SOMEBODY has defined a Bolshevik as a man who has nothing and wants to divide it with everybody. Behind this more or less flippant definition there is an important germ of truth. A study of the records of what Bolsheviks we have known in this country, and those who have called themselves Bolsheviks or I.W.W.'s, or any other name which designates a more or less organized lawlessness, reveals the fact that very few if any own property.

When a man owns property he appreciates the necessity for well organized legislation, and for the necessity of enforcing laws. When the labor class as a whole in any community owns property, it is a law abiding and satisfied class. This is not only progressive in itself, but always carries with it a successful community.

Recent moves by great capitalists of the country to make the laboring man not only a profit sharer in the company in which he works, but also to make him an owner of property in the community in which he dwells, has met with marked success.

The dangerous element is always the floating element. As this is eliminated, stable conditions grow, and contentment reigns in place of discontent. The time has long gone by when large manufacturers and other employers of labor can merely satisfy themselves with paying the weekly wage and forgetting the general welfare of those who help to make their business a success.

The principles of profit sharing and of well organized and thoughtful welfare are becoming more and more firmly embedded in the minds of the executives of the country. No bigger step can be taken than to make the laboring man a property owner.

Radiator Cooling Fans*

Problems of Design and Mounting — Large Diameter vs. High-Speed Fans— Magnitude of the End Thrust on Fans — Means for Insuring Continued Dust-Proofness of Fan Hubs

By George W. Hoyt
Chief Engineer, The Oakes Co., Indianapolis

WHEN the subject of fans is investigated it is usually found that there is a great amount of doubt among engineers as to just what type, size and speed should be used for different motors. The decision should depend largely upon where the fan is to be used, whether on a passenger car, truck, tractor or stationary power unit. In connection with tractor fans, special attention should be given to dust-proofness of the bearings, and the packing retaining device should be adjustable. On passenger cars and trucks it is not so important to be able to adjust the pressure on the felt, though it is desirable there, too.

Most engineers will agree that the fan is given about as little attention as any part on the motor, until heating troubles appear. However, this condition is changing very fast. The first problem is to select a fan of the proper diameter and speed to work in connection with the other units of the cooling system. Too high a fan speed causes noise, while a fan that is too small will cause overheating. In the following, the various items of the cooling system are taken up in the order of their relative importance.

It is, of course, necessary to have the proper pump and radiator capacity to handle all of the water in the system and circulate it at an appropriate speed. After this has been settled, it is advisable to use the largest fan which will clear all radiator connections by at least ½ in., and will not overlap the upper or lower tank. If the fan's sweep were masked by the tanks, it would pull against a solid surface, which would decrease its efficiency.

Projected Area

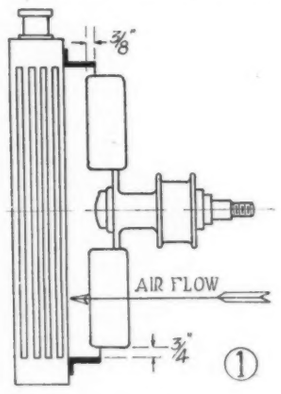
After the diameter of the fan has been determined by the above mentioned method, the projected area of the fan or the blade path should be considered, which largely determines the air delivery. The projected area varies from 1½ in. up to 2¼ in. in accordance with the size of the motor to be cooled. Sometimes it is impossible to get a large diameter fan back of the radiator, and then the next best thing to do is to use as large a blade path as possible and still clear the fan belt by ⅜ in.

Referring to the drawings giving the capacity of different size fans, suppose that a certain volume of air is to be passed and it is found that an 18 in. fan with 1½ in. projected area, running at 1800 r.p.m. will give this air delivery. If you cannot get an 18 in. fan back of your radiator, you may step down to a 16 in. fan with a larger projected area, running it at the same speed as the 18 in. fan. Thus it is possible with a smaller diameter fan, by increasing the size of the projected area, to carry the same volume of air at a given speed. However, the best practice is to use large diameter fans and slow speeds wherever possible.

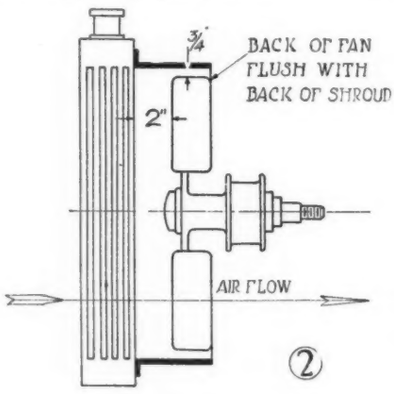
Size of Pulleys and Belts

After having determined the proper diameter and width of the fan blade, we next come to the width and diameter of the fan pulley. We have found by experiment that for fans up to 18 in. diameter, a belt 1¼ in. wide works very satisfactorily. In some cases, however, a manufacturer will drive the generator with the same belt, in which case a wider and heavier belt should be used. Fan diameters larger than above mentioned take belts up to 2½ in. in width. The proper belt width depends upon whether the fan is driven from a large or small pulley at high or low speed. Where the pulleys are small in diameter, and are run at fairly high speeds, a wide belt is necessary to avoid slippage. Sometimes it is not possible to get a large area of belt contact on the pulley, and a wide belt must then be used. It will always be found that, owing to the effect of weather conditions, water, oil and heat, the cost of a little extra belt width is money well spent. There is some doubt as to which is better, a crowned face pulley or a flat face pulley. This depends somewhat upon the width of belt. The flat pulley will work very well with a wide belt, that is, belts of such widths as mentioned above. However, tests made by us showed that a crowned face pulley is preferable, because it tends to keep the belt centered on the pul-

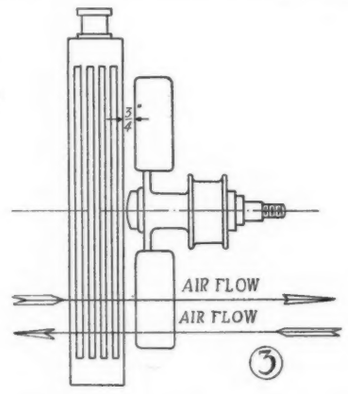
*From a paper read before the S. A. E. Minneapolis Section.



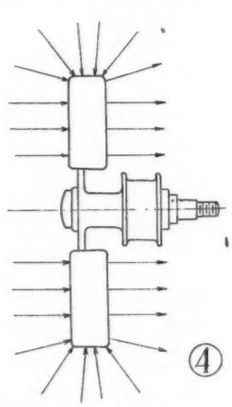
Location of fan in relation to radiator and shroud when blowing air



Location of fan in relation to radiator and shroud when drawing air



Location of fan in relation to radiator without shroud when blowing or drawing air



How a curved four-blade fan handles the air

ley, thereby getting the benefit of the full width of the belt. With flat, flanged pulleys, if the driven and driving pulleys are not absolutely lined up with each other, the edge of the belt tends to ride on the flange, which tends to decrease its pulling power. Another factor determining the necessary belt widths is the material of which the belt is made. Some belting material will stretch more than others, and cause slippage, and wide belts minimize this trouble. It all works out to this, that no matter how efficient the fan may be, if the belt is too small and there is slippage, the fan will be more or less of a failure.

Next it is necessary to determine the diameter of the fan pulley. This depends somewhat on the air delivery. Tests made in our laboratory, as well as by radiator manufacturers, have shown that for motors up to 50 hp. the air velocity through the radiator should be from 1500 to 1800 ft. p.m. depending upon the size of motor to be cooled. The pulley preferably should not be less than 2½ in. in diameter, as smaller pulleys are very apt to allow belt slippage, and decrease the fan speeds quite considerably. The fan speeds, of course, will vary, and in deciding upon this factor it should always be borne in mind that a large fan running at slow speed is the most efficient. This statement is corroborated by the volume curves and horsepower curves in Figs. 5, 6, 7 and 8. The fan pulley then must be of such diameter that, considering the diameter of the driving pulley and the speed of same, the fan will be rotated fast enough to carry the required volume of air, and the driving pulley should always be large enough to allow of a fan pulley diameter of at least 2½ in.

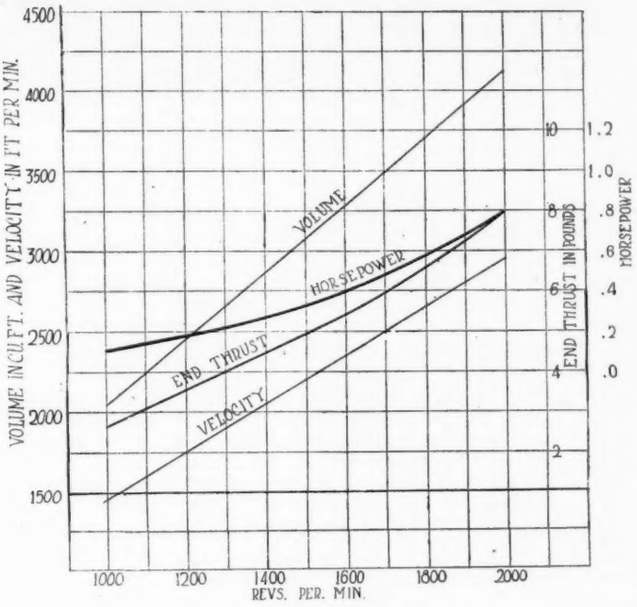


Fig. 5—Volume of free air handled, velocity of air, horsepower required to drive, and end thrust of a 16-in. diameter, 2¼ in. projected area, 4-blade pressed steel fan. Air tunnel diameter 16 in.

Fan Locations

We will next refer to the location of the fan. Some manufacturers use a fan shroud on the radiator, while others do not, and the proper location of the fan is very much affected thereby. Where a radiator is used without a fan shroud, the fan should be set with the front edge of the blades ¾ in. from the back of the radiator core, so that there will be a minimum loss. By referring to Fig. 4 it will be seen that when set farther away, the fan would pull the air from the top and sides of the hood, instead of through the corners of the radiator. This distance is also great enough to permit quiet operation, and allow for regular shop variations. This fan location, shown in Fig. 3, is satisfactory for blowing air as well as drawing air through the radiator without a fan shroud.

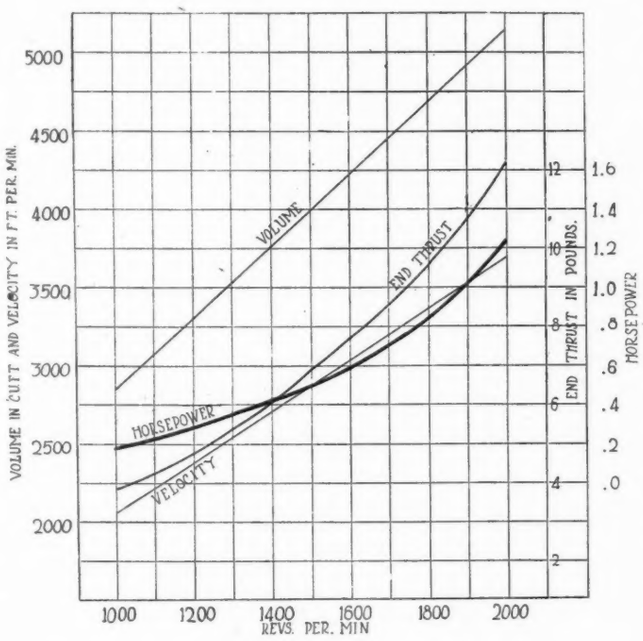


Fig. 6—Volume of free air handled, velocity of air, horsepower required to drive, and end thrust of an 18-in. diameter, 2¼ in. projected area, 4-blade pressed steel fan. Air tunnel diameter 16 in.

Fig. 2 shows the proper location of a fan when using a shroud and the air is drawn through the radiator. The front edge of the fan blades should be 2 in. away from the back of the radiator core, and the fan shroud should be so designed that its back edge will come flush with the back edge of the fan blades and that there will be about ¾ in. clearance between the shroud and the fan. If a fan is set closer than 2 in. to a radiator with shroud, it will be noisy, as with the fan operating in a shallow pocket the air gets no chance to spread and take a free course through the fan. Tests have shown that a fan located as shown in Fig. 2 gives very good results.

There should be a number of louvres in the side of the hood, of the proper size to allow the warm air to escape. Attention should also be given to the location of the floor boards and anything else that tends to increase the resistance against which the fan has to work, which parts should be so arranged as to allow the free escape of the warm air from under the hood.

Construction of the Shroud

The shroud should be made without sharp angles and corners, as these bank the air, holding it in the shroud and forcing it back through the corners of the radiator. This same effect is produced where a shroud overlaps the back of the fan blades, as it will not allow the air to get away from the fan. Quite often one-half of the blade width only is within the shroud, but this location is not the best, for the following reason: Fig. 4 shows that air is drawn in all around the end of the blade, and with the arrangement described half of the blade would draw warm air from under the hood, off the motor, and tend to keep this air circling around the end of the blade, thereby decreasing the true air delivery, as compared with the arrangement of Fig. 2.

When the radiator is in front of the motor the fan may be placed in front of the radiator. In this case the air should always be blown through the radiator, thus at the same time carrying the hot air off the motor. If the air were drawn through the radiator the hot air from around the engine would pass through and warm the water instead of cooling it. There is, however, one objection to placing a fan in front of the radiator, namely, that if not properly protected, the fan draws dirt and weeds that are lying loose in the field, and is apt to clog the radiator and interfere with its proper functioning. A front-mounted fan without shroud should be preferably located as shown in Fig. 3, with a view to forcing all the air possible through the radiator. Where it is neces-

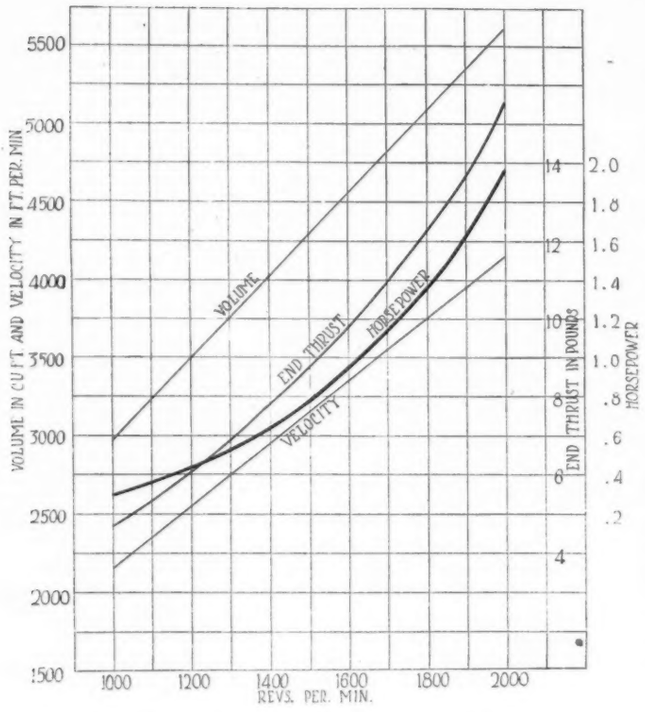


Fig. 7—Volume of free air handled, velocity of air, horsepower required to drive and end thrust of a 20-in. diameter, 2¼ in. projected area, 4-blade pressed steel fan. Air tunnel diameter, 16 in.

sary to use a shroud with the fan in front of the radiator, we have found it to be very good practice to locate the fan as shown in Fig. 1. The fan is located with the front edge ⅜ in. inside the shroud, to keep from spreading the air outside of the shroud, and at the same time leaving the largest portion of the blade out in the open air, in order to obtain the maximum amount of air. By locating the fan 1½ in. back from the radiator, enough space is left between the fan and radiator to spread the air so that it will pass through the corners of the radiator as well as the center.

For tractor purposes the use of a fan shroud is recommended, as great cooling capacity is necessary, and there is a gain of about 10 per cent from the use of a shroud, which is due to the fact that the air can be drawn through the corners as well as any other section of the radiator.

There is one other possible location of a radiator, viz., back of the motor and at the dash. In most cases it is necessary to place the fan back of the radiator, and drive it off the fly-wheel or propeller shaft, using the arrangements shown in Fig. 1 and 3, depending upon whether or not a fan shroud is used. The real objection to this fan location is that in most designs it is backed up so close by the toe boards that it is impossible to get the maximum efficiency out of the fan. However, the direction of air flow should be such that the warm air from the motor will not pass through the radiator.

In connection with the volume charts Fig. 5, 6, 7 and 8, it should be pointed out that in making the tests gasoline was used in the pitot tube and manometers. Both the static pressures and the velocity pressure were taken into consideration in reading the height of the gasoline column. The fans were driven by a 5-hp. motor and were located in an air tunnel tapered down to 16 in. diameter, the tunnel being 15 ft. long. The volume test was made at the same time. We are thus equipped to determine the end thrust of the fan and the horsepower consumed in driving it. The pitot tube is considered the most accurate means for determining air velocities and results obtained with it should not be compared with volume figures secured by the use of the anemometer, as the anemometer is only approximate for velocities as low as 1000 to 1500 ft. p.m., which with the average size fan corresponds to 800-1000 r.p.m.

We will now take up the choice of bearings, as the bearings are one of the most important parts. Quietness of operation, freeness of motion and the life of the fan all depend upon the type and quality of bearings used.

There are practically three types of bearings used for this purpose, namely, roller, annular, ball and cup and cone ball bearings. The latter is by far the most popular bearing for fan use, about 75 per cent of the fans on all of the trucks, tractors and passenger cars manufactured to-day being fitted with it.

Here some consideration should be given to the different loads on fan bearings. The radial load is due to the weight of the hub, blades, spider and all parts that revolve on the bearings, plus the tension of the fan belt necessary to secure a drive without belt slippage. In addition to this radial load, there is another load which is a very important factor. As the fan must draw or blow the air through the radiators, a great percentage of the load on its bearing becomes end thrust. In the past there has been a certain difference of opinion among engineers as to the amount of end thrust caused by different rates of air delivery. The end thrust depends upon three factors—the fan diameter, the projected area or the blade path, and the speed of the fan. A fan running in free air will produce a certain end thrust, but when this same fan is placed back of a radiator, between the radiator and the dash, and under a hood, the end thrust is increased about 25 per cent, depending upon the restriction of the air passage. The air will flow more easily through some radiators than through others, some motor hoods have better air outlets than others, but, in any case, there is plenty of end thrust, and this must be given serious thought.

We will now go back to the bearings. A straight roller

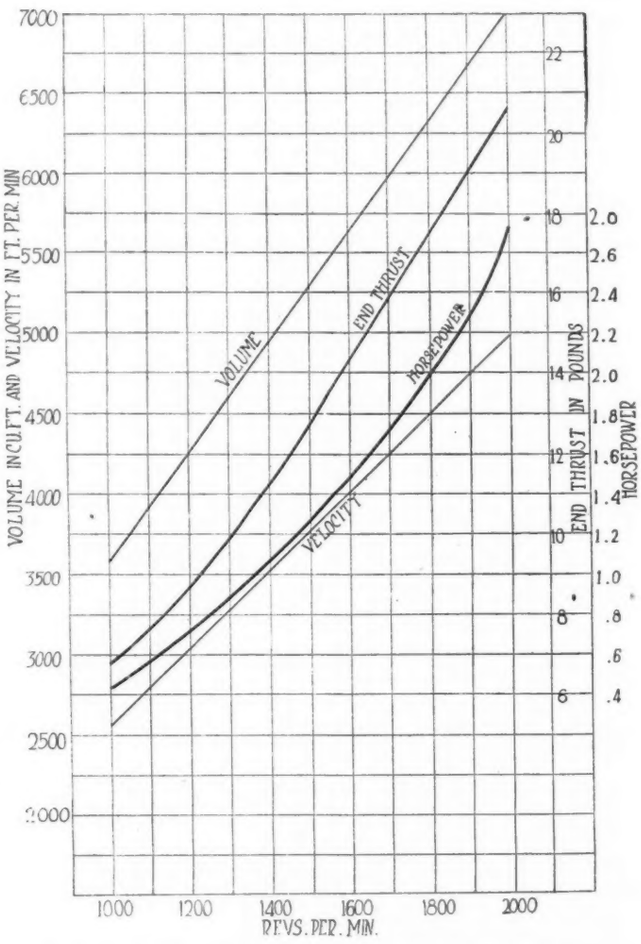


Fig. 8—Volume of free air handled, velocity of air, horsepower required to drive and end thrust of a 22-in. diameter, 2¼-in. projected area, 4-blade pressed steel fan. Air tunnel diameter, 16 in.

bearing designed to take radial loads only, when used with a hardened and ground outer sleeve and a hardened and ground spindle, will make a very satisfactory bearing for taking care of the radial load of the fan, but there must be some special arrangement made to take care of the end thrust. The amount of this end thrust is such that it should be taken care of by a ball thrust bearing. From Fig. 8 it can be seen that a 22 in. fan with 2¼ in. projected area, running 2000 r.p.m. and delivering 6890 cubic feet of air per minute through a 16 in. tunnel, will produce an end thrust of about 20 lb.

It can be safely said that not more than one out of every ten people driving cars ever oils the fan, and if a plain washer thrust bearing does not get oil, it will not be long before it gets loose enough to rattle. Ball thrusts, of course, also will wear out in time, but there is no question that there is not as much friction in the ball bearing as there is in the plain bearing, as the balls have only a line contact with the ball race, while the entire surfaces of plain thrust washers are rubbing together. I think I am safe in stating that there are very few engineers who have had experience with end thrust bearings who will not agree that the ball end thrust makes a higher grade construction.

As to the amount of end thrust, this can be found from Figs. 5, 6, 7 and 8 for different sized fans running at different speeds.

Referring to fans with annular bearings, this type does not need much of an introduction. When the proper size of bearing is used it will give satisfactory results, and carry both radial and thrust loads, but, of course, it must be kept properly oiled.

Next comes the cup and cone type bearing, and the popularity of this type is in itself proof of the efficiency of the bearing. The cup and cone type of bearing is adjustable both for radial load and for end thrust; when properly built and adjusted it will run longer under the abuse that a fan gets than any other type of fan bearing, with one possible exception, which is the annular bearing. These two bearings are very much alike, as far as carrying load is concerned, only that one is adjustable and the other is not. It is possible that the cup and cone bearing needs a rather delicate adjustment in order that it will work properly and be long-lived. However, this is true of any adjustable bearing, as, for instance, thrust bearings in the form of plain washers. These washers must not be clamped too tight, as they will then score and bind, and neither must they be too loose, as they will then rattle.

The one great secret of long-lived bearings is to make the hub as tight as possible, so that the oil can be kept in and the dust out. In order to do this, the hub must be designed to hold a good amount of oil or grease, and the felt washer retainers must be made adjustable so that oil can be kept in. A felt washer packing without adjustment will in time wear large around the shaft, and become oil-soaked to such an extent that it gets soft, when it is worse than no washer at all. With proper adjusting means the felt can be kept tight to the shaft, and the oil out of the felt, thereby making a much tighter fan hub. Why do we put adjustable felt washer retainers on our differential carriers on the rear axle, or on our front wheel bearings, or on our transmission bearings? We do it to keep the washers tight. There is the same need of a tight washer on a fan hub, which is the highest speed part of the motor.

The curves shown in Figs. 5, 6, 7 and 8 were drawn from tests made in the Oakes company laboratory and all except the end thrust figures were verified by the American Blower Co. of Detroit, which is recognized as an authority on fans.

The writer hopes that he has made clear the points which should be given special attention in order to lay out an efficient cooling system. He believes to have made it clear that any one unit cannot do all of the motor cooling, but all units must be designed to suit each other, and he would suggest that the manufacturers of trucks, tractors and passenger cars co-operate with the accessory manufacturers so that the latter can help solve the mechanical troubles met with.

Steam Power and Fuel Conservation

By Dr. C. P. Schwarz

REFERRING to your S. O. S. call for fuel economy, a handbook which I received while in London in 1914 states that a certain motor when operated on gasoline with specific gravity of 0.708 showed an efficiency of 27.5 per cent. The same motor when run on 0.745 gasoline showed an efficiency of 25 per cent. Evidently the constituents with a higher boiling point escaped—at least partly—without performing work. This would point to air-cooled engines.

Further economy could be effected by the use of smaller engines and 4-speed transmissions, less weight per unit of useful load, streamline bodies, etc.

It is perhaps not known generally that a steam engine working with steam at 600-700 lb. and having a proper valve gear has a theoretical efficiency of 28 per cent and even higher. It has been pointed out in a leading British engineering paper that 1 kilowatt has been produced with 8 lb. of steam in turbo-generators of no unusual size.

The well-known Swedish engineer, De Laval, constructed about 1894 a steam power plant which aimed in the direction of fuel economy; lack of funds stopped the development.

A properly designed steam plant, taking the thermal efficiency of the cycle at 28 per cent, the mechanical efficiency of the steam engine at 85 per cent and the thermal efficiency of boiler and furnace likewise at 85 per cent, would have a total efficiency of $28 \times 85 \times 85 = 20$ per cent or almost as great an efficiency as the average gasoline engine. (A Continental truck motor described in your paper 1919 shows 21 per cent.) But here is the rub: The efficiency of an internal combustion engine increases with the load, while a properly designed steam engine acts just the opposite. As most motor car power plants are over-engined they run a considerable time on part load and then their average efficiency is below 20 per cent, while the efficiency of the steam engine drops below the figure only on exceptional pulls.

As far as fuel is concerned the steam plant may be designed to take any fuel that will flow through pipes and contains a great deal of heat energy.

The comparison between gasoline and steam engines becomes very disadvantageous for the former if we look at it from a broader viewpoint, *i. e.*, from the conservation-of-natural-resources point of view.

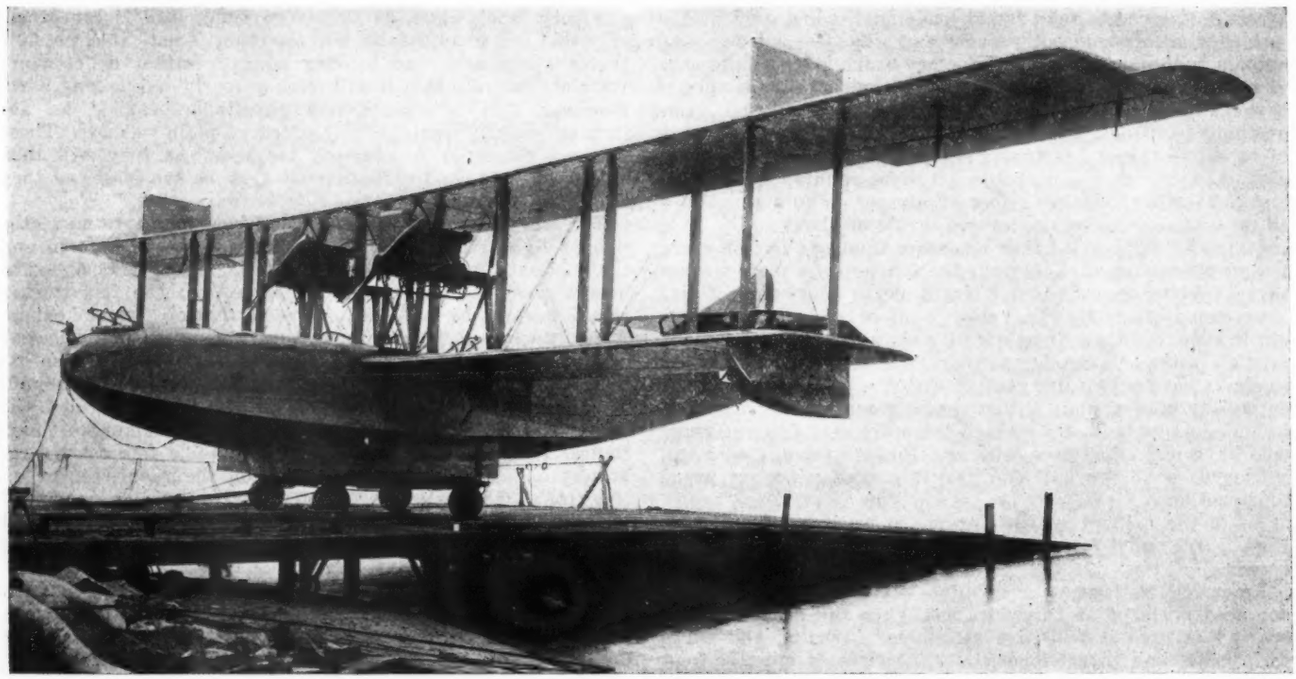
From a Government publication on the Rittman cracking process I see that oil free from natural gasoline will produce about 50 per cent cracked gasoline, 25 per cent residual fuel oil and 25 per cent non-liquefiable gas. This gas is an absolute loss from a motive-power point of view, and there the efficiency of the gasoline engine, viewed from this broader standpoint, is $75 \times 21 = 15\frac{1}{2}$ per cent, or considerably less than for a steam engine, which uses the 100 per cent of the oil drilled.

From a strictly thermal point of view the possibilities of the steam car are not to be sneezed at.

Substitute for Manganese

IN a recent article in the *Pester Lloyd*, reference is made to a new process by which manganese is largely superseded in iron-founding, according to a method discovered years ago, but abandoned owing to the plenitude of manganese.

In its improved form the process effects a saving of 50 to 75 cents per ton, as compared with the calcium carbide substitute of the Thomas process, used by the German-Luxemburg Mining & Ironfounding Co. The method, which requires only 4.5 lb. of 30 per cent ferromanganese per ton of iron, has been evolved by the Hasper Iron & Steel Works, and the owners have placed their discovery at the disposal of the Union of German Ironfounders, so that all German iron works may be enabled to husband their manganese reserves to the utmost.



Three-quarter front view of the F-5-L Navy flying boat, which has a wing spread of 103 ft., a boat hull 45 ft. long and 10 ft. wide, and weighs in fighting trim approximately 7 tons

F-5-L Navy Flying Boat

Twin-Motored Tractor Biplane with Total Flying Weight of 7 Tons—Cruising Radius as a Fighter, 10½ Hours—Normal Crew Four Men

Part I

By S. T. Williams
Assistant Chief Engineer, Naval Aircraft Factory, Philadelphia

LITTLE has been said and less printed concerning aircraft development by the Navy during the World War —but much has been done. Seaplanes, rivalling the Handley-Page and Caproni in size and performance, have been quietly built in large quantities and have had no little part in subduing the submarine and keeping our domestic commerce safe.

Of these the F-5-L boat seaplane is distinctive. It is a twin-motored tractor biplane, having a total flying weight of nearly 7 tons, a cruising radius of 10½ hours as a fighter, or 8½ hours as a bomber. It carries a military load of over 1400 lb., with a crew of four men. This machine is a formidable engine in naval war craft, and it is so designed that it may be quickly and efficiently made under war conditions.

In the case of this machine the Navy, as did the Army, took a foreign design and modified it to meet American production methods. It is interesting to note, however, that in this particular case the English design had been based upon an American model, the large Curtiss flying boat—the H-12 which was the forerunner of both the H-16 and the F-5-L.

The F-5-L is a somewhat larger machine than either the H-12 or the H-16 and is capable of carrying a greater useful load. It was developed at Felixstowe, and the name "F-5" was chosen to denote the English experimental seaplane factory at Felixstowe ("F") and the model number design in machine ("5"). The Navy added the letter "L," indicating that, as built here, it is driven by Liberty engines.

The lines, overall dimensions and main constructional features were worked out in England and an experimental plane was constructed there. The details with many modifications were worked out at the Naval Aircraft Factory, Philadelphia, to correspond to its production methods. The planes were then put into production at that and other factories, such changes from the first drawings being made as were found necessary by tests.

Fundamentally the plane is similar to our American Curtiss flying boats—particularly the H-16 model. But in size and details it is quite different, being larger and better fitted to emergency production. For example, with few exceptions the fittings are soft sheet steel, cut from flat patterns and bent to shape.

This obviated the necessity of dies and drop forgings, which are particularly difficult to obtain under war conditions. The struts, likewise, are uniform sections, that is, not tapered, so that they can be shaped with a minimum of hand labor. Throughout, the parts are such that duplication is easy, production methods possible, and readily available equipment suitable.

The specifications herewith will give some idea of the size and capacity of this seaplane. It will be noted that the lift per square foot of surface is from 9.3 to 9.5 lb. per square foot and is somewhat greater than land practice.

The F-5-L is the latest development of the boat type seaplane, having the tail surfaces carried on the fuselage construction and the fuselage entering into the hull of the boat. The Curtiss boat seaplane may be considered a forerunner of this type. The characteristics are a fuselage similar to that of a land machine, planked in to form a boat body and having planes or steps similar to a hydroplane at the forward end.

Specifications of Navy F-5-L Flying Boat

Overall upper wing (including ailerons)	103	ft.	9⅝ in.
Overall lower wing	74	ft.	4 in.
Overall length of boat	49	ft.	3 11/16 in.
Overall height of boat	18	ft.	9¼ in.
Wing chord (H-12 curve)	8	ft.	....
Gap between upper and lower panels C. L. beams	8	ft.	10½ in.
Angle of incidence of wings plus	3	deg.	40 min.
Dihedral of wing	1½	deg.	....
Stagger of wings	None		....
Angle of incidence horizontal stab. plus	2½	deg.	....
Engine sect. panel	108	sq. ft.	....
Interm. and upper outer panels (311 sq. ft. each)	622	sq. ft.	....
Ailerons (59 sq. ft. each)	118	sq. ft.	....
Sidewalks (33 sq. ft. each)	66	sq. ft.	....
Lower wings (240 sq. ft. each)	480	sq. ft.	....
Non-skid planes (15 sq. ft. each)	30	sq. ft.	....
Horizontal stabilizer	121	sq. ft.	....
Vertical stabilizer	35	sq. ft.	....
Elevators (28 sq. ft. each)	56	sq. ft.	....
Rudder	33	sq. ft.	....
Total lift surfaces (including ailerons)	1394	sq. ft.	....
Hull length	45	ft.	3 11/16 in.
Hull width	10	ft.	....
Hull height	6	ft.	1¼ in.
Pontoon length	7	ft.	....
Pontoon width	..		20 in.
Pontoon height	..		35¾ in.
Power plant	2 Liberties		
Propellers (subject to change), 2-blade	10½ ft.		6¼ ft. pitch

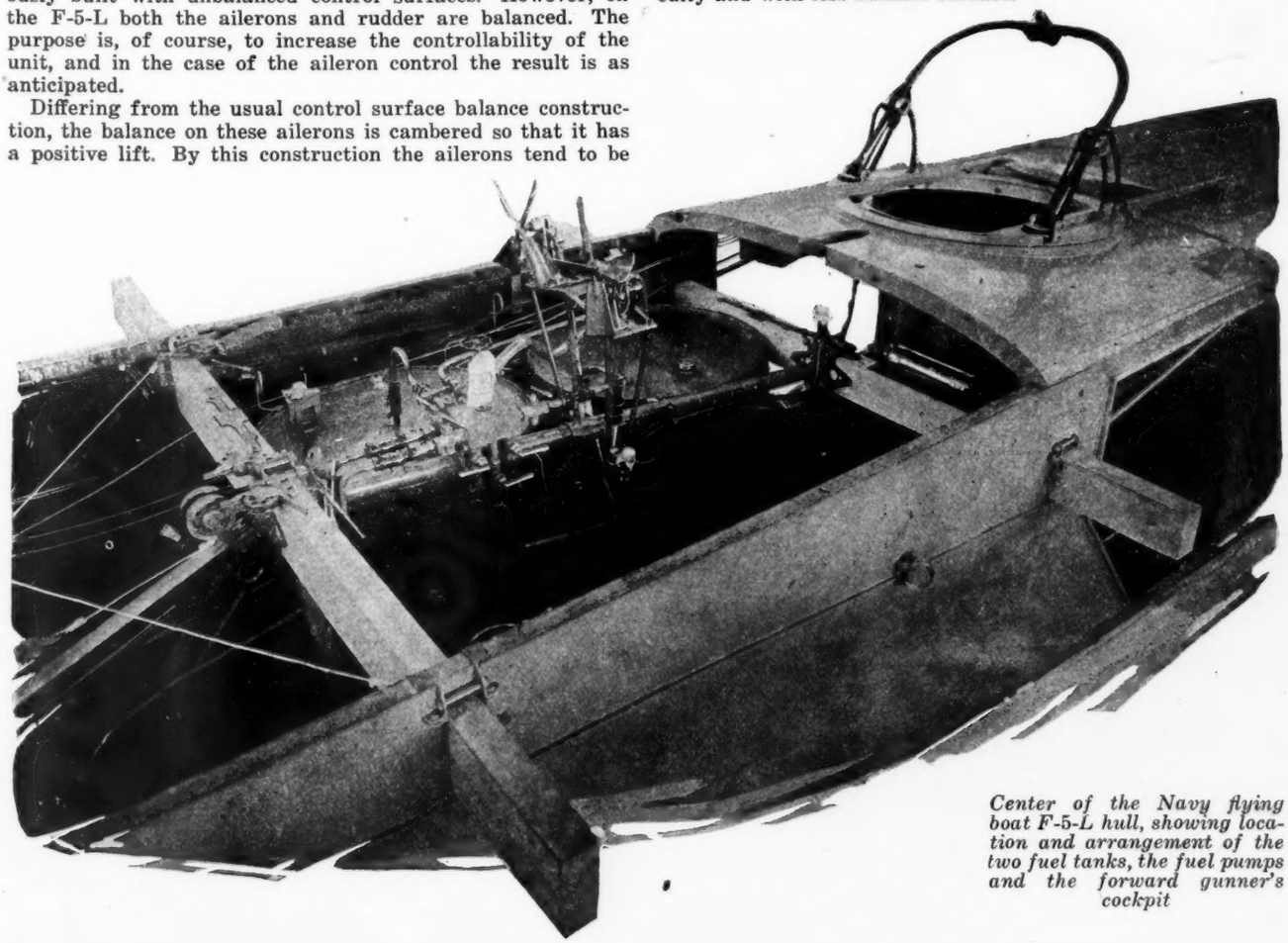
Streamline of Boat Noteworthy

The most noticeable feature in the F-5-L is the degree to which the hull or boat has been streamlined. The hull cover sweeps aft, broken only by the cockpit openings. From an aerodynamic standpoint this is more efficient than the construction of the H-16, where a raised cabin is used.

On this model, as on the H-16, the fin edges are continued aft and join into the lower longeron, giving a much stronger structure and better streamline form. Another feature in the hull construction that is noteworthy is the use of veneer instead of linen doped and painted on the after hull sides. It was found in practice that the linen failed in heavy seas or on a bad landing, but this failure was obviated by the use of veneer.

With few exceptions, all large seaplanes have been previously built with unbalanced control surfaces. However, on the F-5-L both the ailerons and rudder are balanced. The purpose is, of course, to increase the controllability of the unit, and in the case of the aileron control the result is as anticipated.

Differing from the usual control surface balance construction, the balance on these ailerons is cambered so that it has a positive lift. By this construction the ailerons tend to be more sensitive in their action and to operate with less difficulty and with less balance surface.



Center of the Navy flying boat F-5-L hull, showing location and arrangement of the two fuel tanks, the fuel pumps and the forward gunner's cockpit

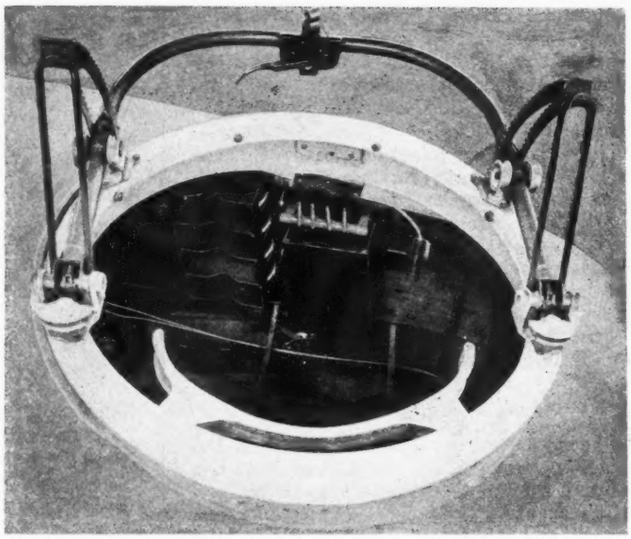
The planing action is increased by the use of vents extending through the hull aft of the rear steps, similar to the vents that are used on the pontoons of the R-6 Curtiss model. It was stated that the hull swept aft in a perfect streamline, and the cabin top over the pilot's cockpit was eliminated. However, a certain amount of protection is afforded the pilot by small adjustable windshields.

Due to the fact that the pilot's head is about on a level with the hull cover, this serves to divert the air currents and protect the pilot with a minimum of air resistance. On straight flying it is possible to pilot the machine without the use of goggles, though caution demands their use.

Function of Seaplane

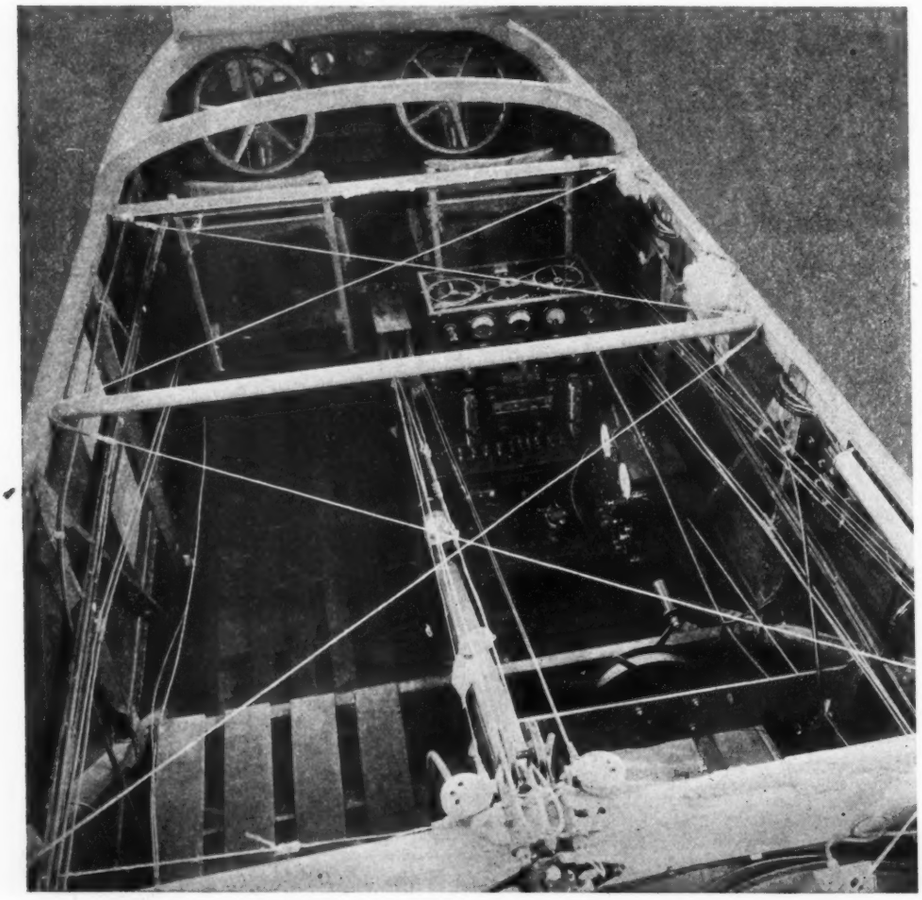
It might be well here to outline briefly the function of this seaplane, that the arrangement of the parts to carry out the duties of the plane may be described. Its chief use is patrol duty over harbors and main lines of ocean travel. Air stations are established along the coast and from these patrols are sent out at regular intervals, each going over a definite area, watching for submarines and possibly convoying transports or freighters. The machines are equipped with bombs and machine guns, the former being used on submarines and the latter on hostile aircraft and water craft on the surface. Special duties such as bombing an enemy harbor or city emergency calls to submarines discovered by other aircraft or water craft require an armament not much different from the above.

A patrol crew usually comprises four men, the pilot, two mechanics and an observer. The observer has many duties—to watch for submarines, drop bombs, man the front machine gun, act as assistant pilot, and possibly be wireless operator. The pilot's duty is to direct the machine and he is first in command. The function of the crew is to handle the gasoline distribution, care for the engines, and man the aft machine guns in any fight that may occur. It is also their duty to have all parts of the machine under continuous inspection during flight and notify the pilot if any part is wrong.



Forward gunner's cockpit on the F-5-L Navy flying boat, showing arrangement of gun mount and ammunition racks

The whole layout of the machine is such that these duties may be most readily carried out. The observer's cockpit is in the nose of the machine and from it the widest range of vision is possible. At the bow is mounted the bomb sight and adjacent to it are the bomb release pulls, ammunition racks, signal pistols, binoculars, etc. A machine gun turret is mounted on the scarf-ring of the forward cockpit, so that the observer may aid in repelling aircraft attacks or, if necessary, sweep the deck of the submarine with machine gun fire.



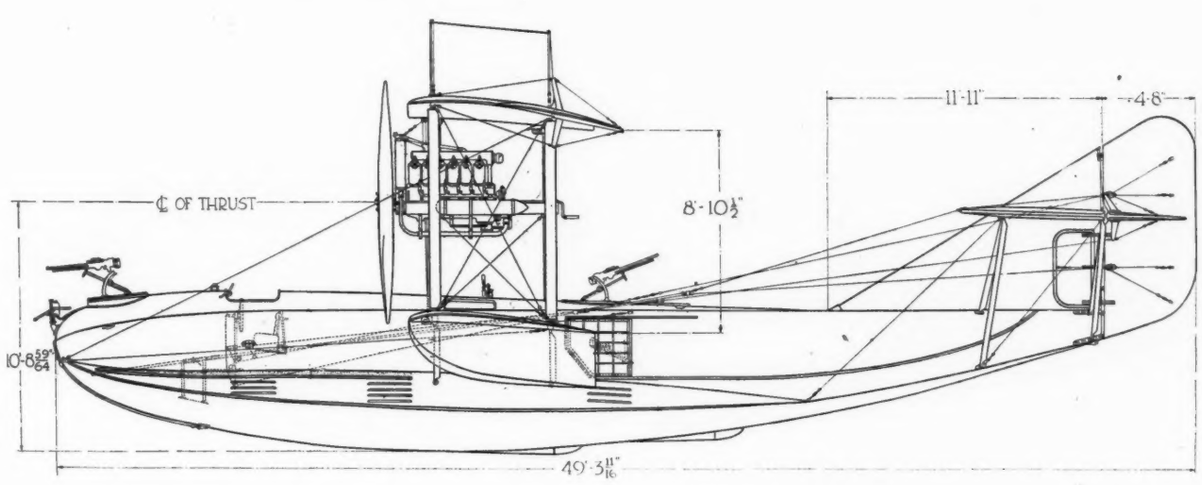
Looking into the F-5-L hull at the twin pilot's seats and the wireless operator's quarters and equipment

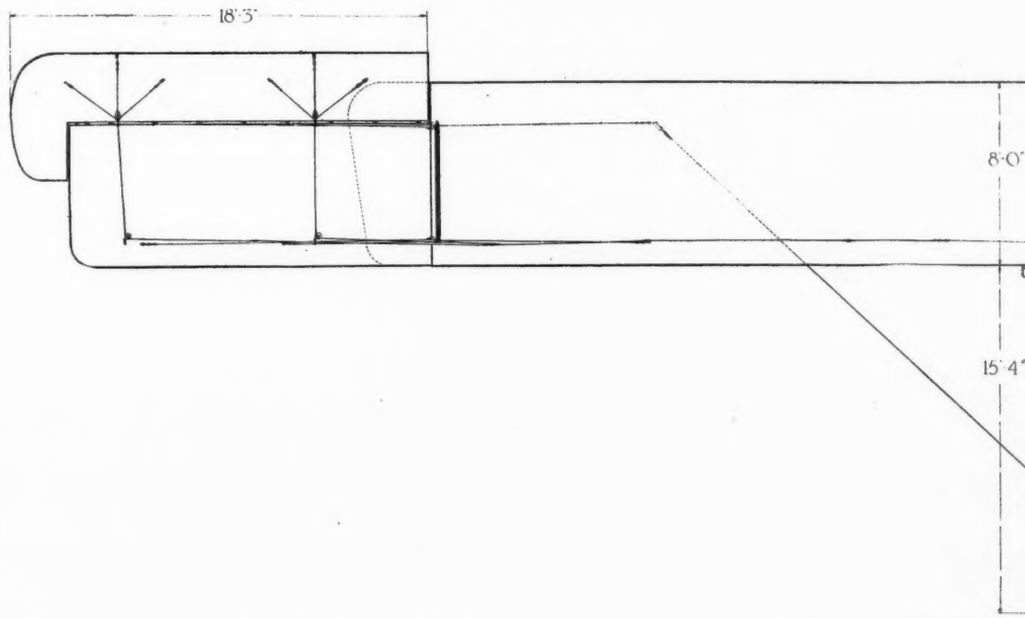
The pilot's cockpit is just aft the observer's cockpit, and may be readily reached from it when the machine is in operation. The pilots are seated on comfortable seats, hinged on a bulkhead and attached to a transverse tube by means of a snap catch that may be instantly released. This permits the observer to pass aft at will without disturbing the pilot.

A wheel control of the dual type is used. It comprises a laminated ash yoke on which are mounted the two aileron wheels connected by an endless chain. An instrument board containing tachometers, altimeters, air speed indicator, oil pressure indicators, inclinometer, and pilot-directing bomb sight is mounted directly in front of the pilot.

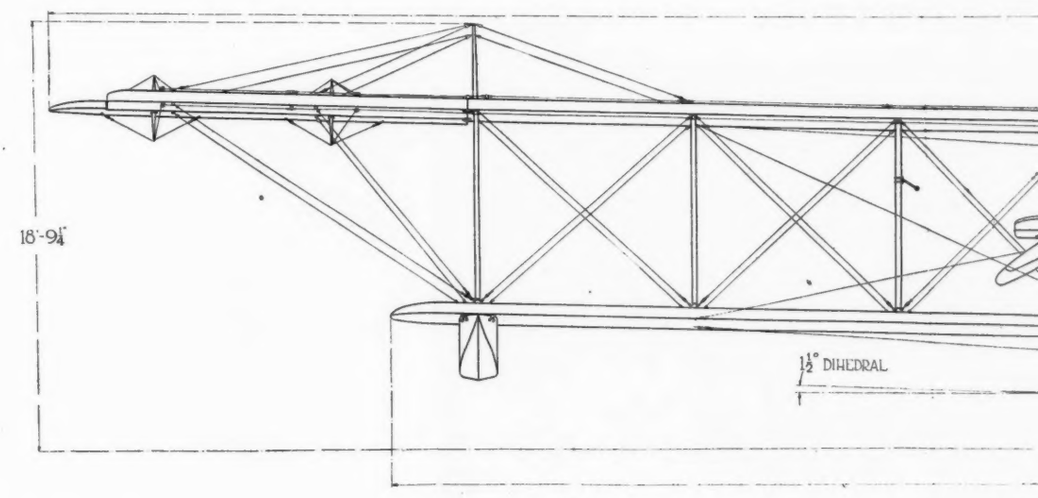
On the starboard side of the hull are the individual engine switches, ammeters and emergency switches, together with the circuit breakers. The two compasses are mounted at some distance apart, so that they cannot interfere with each other. One is on the deck and the other on the floor. All instruments are self-luminous, but instrument board lights are provided.

The spark controls are at the





***THIS** is a twin Liberty engined tractor biplane with a total wingspread of 103 ft. and a boat hull 45 ft. long and 10 ft. wide. The cruising radius as a fighter is 10½ hours and 8½ hours as a bomber. The total weight in flying trim is approximately 7 tons.*



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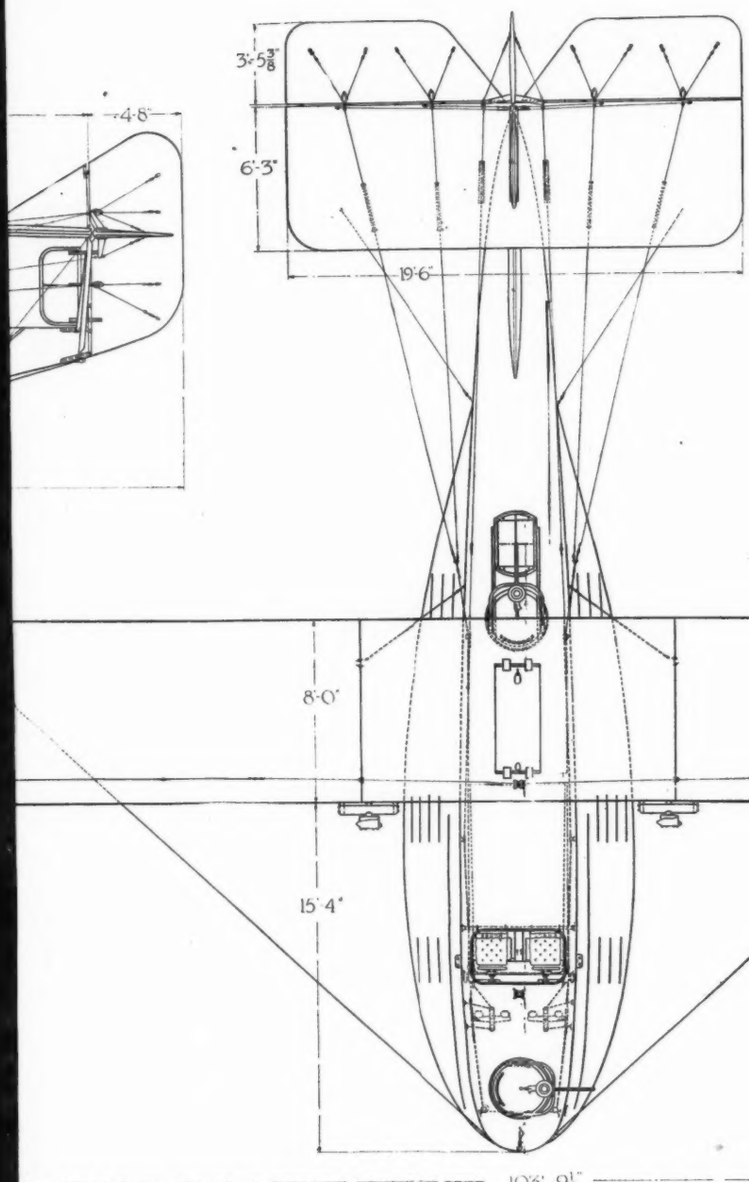
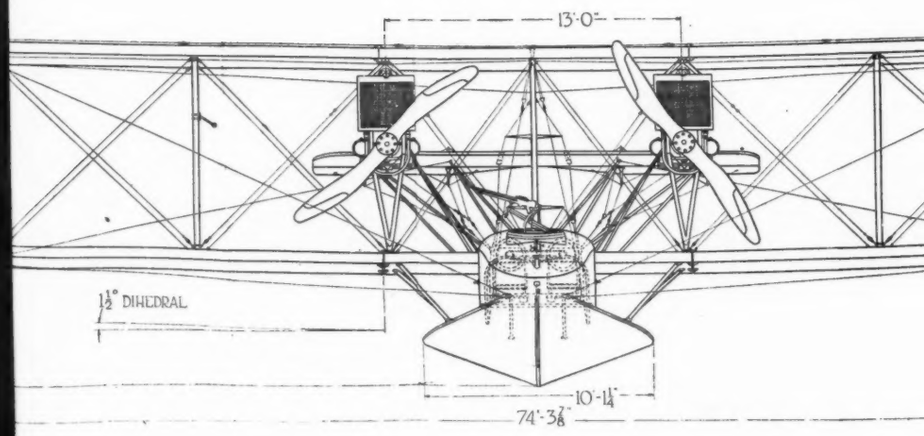
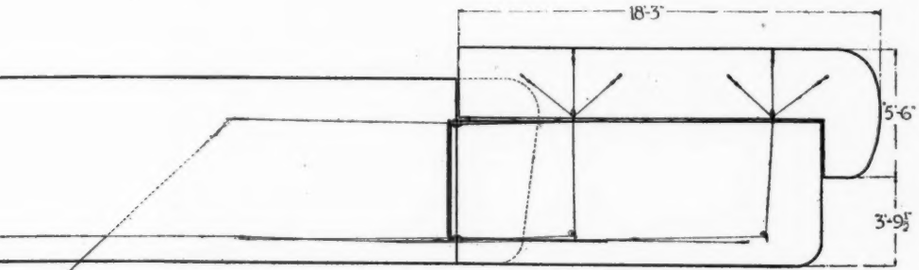
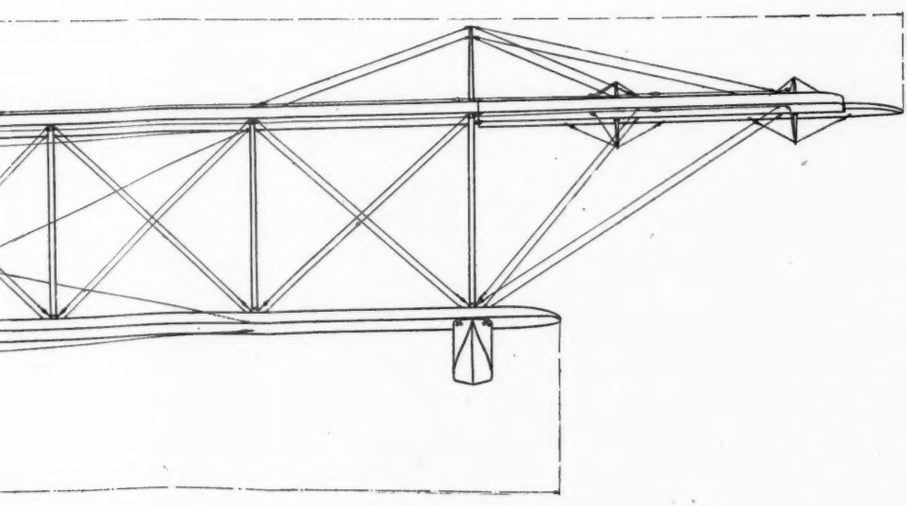




Scale Drawings of Navy F-5-L Flying Boat





starboard side of the starboard pilot's seat, but the throttle controls are between the two pilots, so that either may operate them. Fire extinguishers are placed convenitnely at each station, those in the pilot's cockpit being attached to the bulkhead beneath the seat.

The wireless operator's station is on the starboard side just aft the pilots. The equipment is mounted on a small veneer table, and used in conjunction with a telescopic mast that is carried in the stern. A celluloid window in the hull side provides necessary light.

Mechanics Stationed Amidship

The mechanics' station is amidships by the gasoline tanks and pumps, and their main duty is to see that the plane is "trimmed" by pumping gasoline from the tanks alternately; to see that the engines do not overheat, and that all parts function properly. The water and oil thermometer are mounted on the sidewalk beam adjacent to the mechanics' station.

Aft the mechanics' station, or wing section, is the rear gunner's cockpit. Three guns are accessible from this station, and it also provides a good point of observation or position for aerial photography.

All machines are equipped with inter-communicating telephones, the receivers being incorporated in the helmets and connection effected by terminal boxes at each station. It is thus possible for all members of the crew to be in constant communication.

Voluminous Equipment Carried

In addition to the equipment indicated, the following are some of the miscellaneous items usually carried: Tool kits, water buckets, range and running lights, pigeons, emergency rations, drinking water, medicine chest, sea anchor, chart board, mud anchor, anchor rope, heaving lines, signal lamp, binoculars, Verys pistol, ammunition, life jackets, and possibly electric warmers. Included also are the priming cans, drinking cups and usually several personal items. All this is exclusive of the ordnance equipment of bombs, machine guns, etc.

Considering the size of the machine and the amount of material carried, the performance is quite remarkable. In fact, it compares very favorably with the performance of land planes having the same specifications and not hampered by the heavy boat construction.

The time required to get the machine from the water varies with the wind velocity, but with a 15-mile wind and the plane fully loaded, from 30 to 40 sec. is required. The speed at take-off is about 47 knots on the air speed indicator, and a machine of this design has made a climb of 4200 ft. in 10 min.

Horizontal Speed 85 to 90 M.P.H.

A horizontal speed of from 85 to 90 m.p.h. is attained, but on patrol duty they are generally flown at a more economical speed, such as 70 m.p.h. When geared Libertys were tried out in one of these machines a speed of 102 m.p.h. was attained, but this was a special power plant equipment.

The engine revolutions are about 1500, though this, of course, varies with the types of propeller used. At full speed the gasoline consumption is about 65 gal. per hour and the oil consumption about 2.6 gal. per hour. By throttling down the engine to 1350 r.p.m., or to a speed of about 60 knots, the gasoline consumption per hour is reduced to 44 gal., the oil consumption remaining the same.

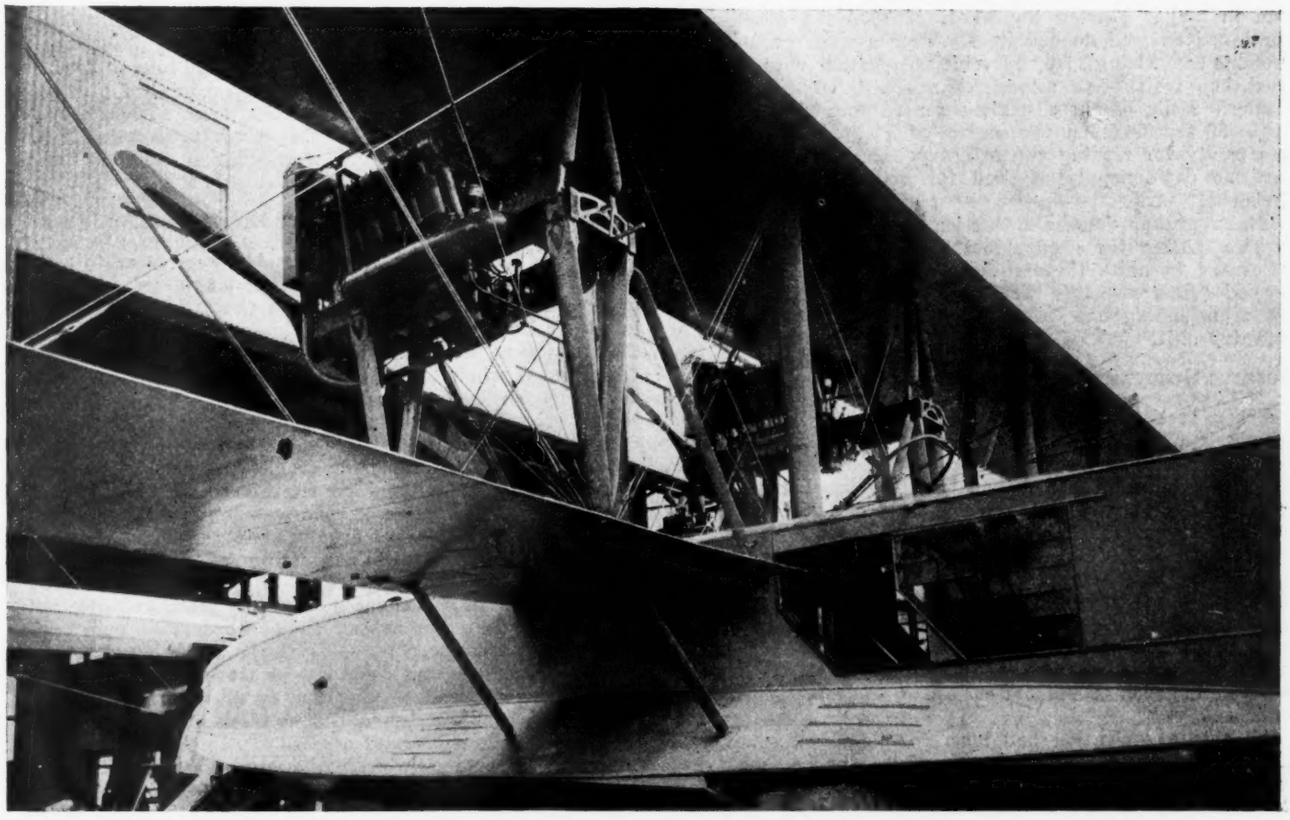
Maximum Cruising Radius 10.6 Hours

This gives a maximum cruising time of 10.6 hours with a light machine or 8½ hours fully loaded. The cruising time at full speed is 7.3 hours and 5.9 hours respectively.

The advantages of operating at cruising speed are many and it is at this speed that the plane is chiefly operated. Among the advantages are increased engine life, greater ease of control, longer cruising radius, less strain on plane parts, and time for more extended observation.

When running at full speed, control is not particularly easy, though under normal conditions one pilot can operate the machine without difficulty. However, the reserve control is necessary to lift the machine from the water, and in cases of emergency, though not ordinarily used.

(To be continued)



Method of mounting the two Liberty engines with which the F-5-L Navy flying boat is equipped. The large sliding window is for observation and permits the use of additional machine guns from this location

When Motor Trucks Saved Verdun

First Complete Description of the Motor Truck in the Greatest Battle of the Greatest War

By W. F. Bradley

THE story of how automobile trucks saved Verdun, and doubtless changed the whole face of the war, was first told in AUTOMOTIVE INDUSTRIES; but when this story was published the war was in progress and the French military authorities objected to the publication of figures and details. Now these restrictions have been removed, and Paul Heuzé in an interesting article in the *Revue des Deux Mondes* gives, for the first time, important statistics on this operation.

During the year 1915 the French Automobile Service had been fully developed on its present and most satisfactory lines. One month after the outbreak of the war the French army possessed between 9000 and 10,000 trucks, of which 6000 were approved army types. The battle of the Marne showed that this number was totally insufficient.

During the whole of 1915 the French Automobile Service purchased trucks which were available in France, America and in Italy. During the whole of 1915 the development continued on well defined lines. Trucks were grouped into sections comprising 17 or 18 vehicles, together with a rolling workshop which was sometimes a truck and sometimes a trailer. Four of these sections united formed a group of 70 to 80 trucks under the control of a captain, and having a capacity for moving one infantry battalion or for carrying one day's supply of food for an army corps of two divisions.

These groups formed a tactical unit of the automobile service. After the groups had been formed, it was found necessary to unite these in companies of six, which were termed "groupments." These groupments had a capacity for transporting one brigade, which is the highest purely infantry unit.

Reserve Groupments

These sections, groups and groupments, consisting respectively of 18, 72 and 432 trucks, were attached to their respective armies and carried out the regular daily work of these armies. The idea had been developed, however, of forming reserve groupments which would be at the disposal of the General in Chief and used for whatever work he might indicate. This move had been rendered necessary by the fact that the army had found it important to provide for rapid movements of troops by means of automobiles. As the groups and groupments had their regular daily work with the army, they could not be relied upon for bigger movements of troops; hence, the formation of the reserve groupments, each groupment consisting of from 1200 to 1500 vehicles.

All this organization had been completed when, at 7.15 a. m., Feb. 21, 1915, the German army launched what has been described as the greatest battle of the greatest war. For 9 hours 2000 German guns shot several million shells of all kinds into the French front lines. Under such a deluge of shrapnel, high explosive, asphyxiating and tear shells, the French lines were flattened and the troops obliged to retreat. The German attack was skilfully organized, for the French line of supply was limited to one single-track railroad, having a capacity for not more than 2000 tons per day. When this line was cut—and naturally the first object of the German headquarters was to cut this line—the French had no other source of supply than the road; but, even here, the French were in a disadvantageous position, for, from Bar-le-Duc to Verdun, there was and still is but one road, and this only a fourth-class road just wide enough for three vehicles to run abreast.

As soon as it was realized that this was no ordinary local attack, orders were given to the automobile service to prepare to supply the Verdun armies with everything necessary to hold back the German invasion. This was the first occasion in the war, or in any war, on which an army had to rely exclusively on automobiles for its supplies. The task was as follows: to deliver from the railhead at Bar-le-Duc to the region of Verdun an average of 2000 tons of ammunition per day; to transport daily 100 tons of food and varied supplies for 20 divisions, making a total of 2100 tons; to carry up to Verdun, or bring back, from 15,000 to 20,000 men per day; to undertake the removal of supplies and varied army material which were then in Verdun and in danger of being captured by the enemy.

Motor Vehicles at Verdun

Hauled 2,000,000 tons of materials.

Moved 2000 tons of ammunition daily.

Transported 100 tons of food and other supplies to 20 divisions each day, a total of 2100 tons.

Carried 15,000 men to and from front lines each 24 hours.

Removed supplies from Verdun to prevent possible capture by the enemy.

Operated over a 22 ft. road 45 miles long.

Passed a given point on the highway at an average of one vehicle each 14 seconds.

Roads Limiting Factor of Truck Efficiency

As already explained, the automobile service at this time was perfectly organized. The weakest point was the road and road regulations. Truck trains worked satisfactorily, but their limiting factor in very many cases was the road. This had been realized, and just before the Verdun battle developed a scheme had been completed, on paper, to get a maximum efficiency out of the road.

This scheme went into effect in the beginning of the Verdun battle. The 45 miles of road from Bar-le-Duc to Verdun was given over to automobile traffic exclusively. No horse or horse vehicle was allowed on this road under any circumstances. The stretch of road was split up into six zones or "cantons," which were organized in the same way as a railroad. An officer with a squadron of traffic police was made responsible for each zone. He had telephonic communications with posts placed along his road, and also with the chief of the other zones. He had orders to keep traffic moving at a regular rate. No vehicle was allowed to stop. If one broke down and could not be moved within five minutes, it was dragged off the road or even turned over into the ditch so that there should be no block in the traffic. The loss of a vehicle or even of a score of vehicles was a matter of minute importance when the safety of France and of the entire world was at stake.

It was during this time that an improvement, very slight in itself, but destined to have wonderful importance, was adopted. The trucks were split up into sections of not more

than nine and the last truck of each section carried a big red disk. No driver was allowed to approach to less than 100 yards of a red disk. By this means the trucks flowed along the road regularly in groups of nine with equally regular gaps of 100 yards between them. These gaps were made use of by touring cars which could pull into the openings thus formed and retain their positions until road conditions made it possible for them to move ahead.

The traffic on this 22-foot road was intense and continued day and night. Official papers show that 6,000 trucks passed a given point in 24 hours, this being an average of one vehicle every 14 seconds. At certain times of the day, and sometimes for several consecutive hours, there was a truck every five seconds. There were on this road more than 9000 automobiles, comprising about 3500 trucks, 2000 staff cars, 800 ambulances and about 200 meat-carrying trucks. In addition to these, there were various special automobiles belonging to the Engineering, Artillery, Air Service, Balloon Corps, Camouflage Sections, Telegraphic, Wireless, Photography, and others.

By the month of June the number of vehicles in use on this road had increased to 11,500. These automobiles carried an average of 9000 men and 15,000 tons of supplies every week. They totaled nearly 1,000,000 miles every seven days, or more than 25 times the circumference of the earth. The total tonnage carried by automobiles during the Verdun battle is rather difficult to estimate, for it comprised supplies, valid troops and wounded, frequently all mixed up, but the total is certainly not less than 2,000,000 tons. If the whole of this material were united it would cover an area of 12,000 sq. yd. and attain a height of 650 ft.

When the automobile service undertook to supply the Verdun army with everything it needed, the stipulation was made, first of all, that no horse should be allowed on this road. At that time, this seemed a very small matter, but there is no doubt that but for this stipulation the road service would have broken down, and as a consequence Verdun would have been lost. They also stipulated that the truck trains should carry their loads right through to destination instead of transferring them to horse-drawn vehicles for final distribution, as had been the custom in the French army up to that time. They insisted on authority being given them to organize the road in accordance with their own plan, and they claimed all necessary facilities in order to keep the road surface in condition.

Road Maintenance

One of the most difficult problems was the maintenance of the road. Within 48 hours of this automobile service being organized, large numbers of territorial troops were sent up for the sole purpose of road work. The number of men working at any time was generally about 1200. In ten months these men put on the road 700,000 tons of stone. The absolute necessity of keeping the traffic flowing steadily at all times made it impossible to use steam rollers. The road menders threw the stones down wherever necessary and the automobiles had to roll in this stone. Their orders were to keep the road in good condition but never, under any circumstances, to stop the flow of traffic.

In addition to this, along the roadside little refuges were established and stones brought to these and kept in readiness for placing on the road itself. The task of the road makers was hard. They had to work throughout the severe winter, to remain on the job in all weathers and had to throw in a shovelful of stones whenever there was a gap between two vehicles. Accidents happened at times, but it was the price that the road menders had to pay in the great struggle against the Kronprinz's forces.

Running day and night, without lights, over a rough road frequently shelled by the enemy, with drivers who had to remain on duty from 24 to 75 consecutive hours, it was not surprising that the automobiles soon began to show signs of breakdown. Tire usage was so rapid that at Bar-le-Duc children made a practice of gathering from the road chunks of rubber which had fallen or which had been torn off the tires of the trucks, and sold these at a penny a pound.

To overcome the difficulty, six hydraulic presses were installed at a convenient point behind the lines and were operated day and night, during the whole of the Verdun battle. Although tires were first to show signs of wear, it was not long before mechanical difficulties developed. The drivers had not time to lubricate chassis accessories frequently; all they could do was to add to the supply of oil in the base-chamber. It was impossible to change the oil. There was frequently no time to stop and add water to the radiator. If an engine ran hot, it had to be forced along until a period of calm made it possible to supply more water.

Under such conditions, defects soon began to develop. To make matters worse, the supply of spare parts for American trucks, large numbers of which were used in the Verdun battle, was stopped at this time. To meet this efficiently, the Automobile Park at Troyes had to arrange to manufacture parts for trucks.

On an average the total losses were 3 per cent per month. When the battle began, a repairshop was in operation in the city of Verdun. This was removed under very great difficulties and sent back to Ligny-en-Bellois, where it operated in conjunction with the main repair park, at Bar-le-Duc. In this park were 30 5-ton breakdown trucks, each one of which had two gangs of mechanics. Whenever an automobile was reported as broken down on the Verdun road, one of these trucks was sent out in order to repair it or, if necessary, to tow it home. This was dangerous work, for many of the trucks were broken down by reason of the enemy's action, and not a few of the mechanics who went out to bring in broken trucks paid for their devotion with their lives.

Truck Removing Service

Soon after the automobile service at Verdun had been efficiently organized, an attempt was made to save as much material as possible from the city of Verdun. When the attack began there were more than 6000 civilians in this town. With the city under shellfire and in danger of being captured by the enemy, these people were obliged to move away, but, at first, no vehicles of any kind were available, and it was on foot, carrying with them very meager baggage, that the old men and women and children abandoned their homes.

During the critical period, between Feb. 25 and March 8, a small number of trucks went into the town and removed important documents from the City Hall. By the end of the first week in March, there were not more than two or three civilians in the entire city. After the month of March, a regular truck removing service was organized. Fifteen trucks were turned over for this work, together with a company of soldiers who, in civilian life, had been professional removers. These men went into the city every day and removed furniture, machinery and other valuable material from Verdun to the railroad stations at Bar-le-Duc or other points. This work went on throughout the summer, and by the month of October everything which was worth saving and had not previously been destroyed by the German bombardment had been moved out of the city.

How many men of the automobile service lost their lives in the Verdun battle is not known. The number, however, is considerable, for the trucks took their supplies right up to the batteries and the drivers of ambulances went practically to the first line trenches under cover of darkness. This service had been carefully organized; drivers knew which roads were open to them and which roads could only be used at night time, or during daylight hours by vehicles running singly and at speed. Signs placed along the road showed where truck trains should stop, where vehicles should go through one by one, and where all traffic should stop during daylight hours.

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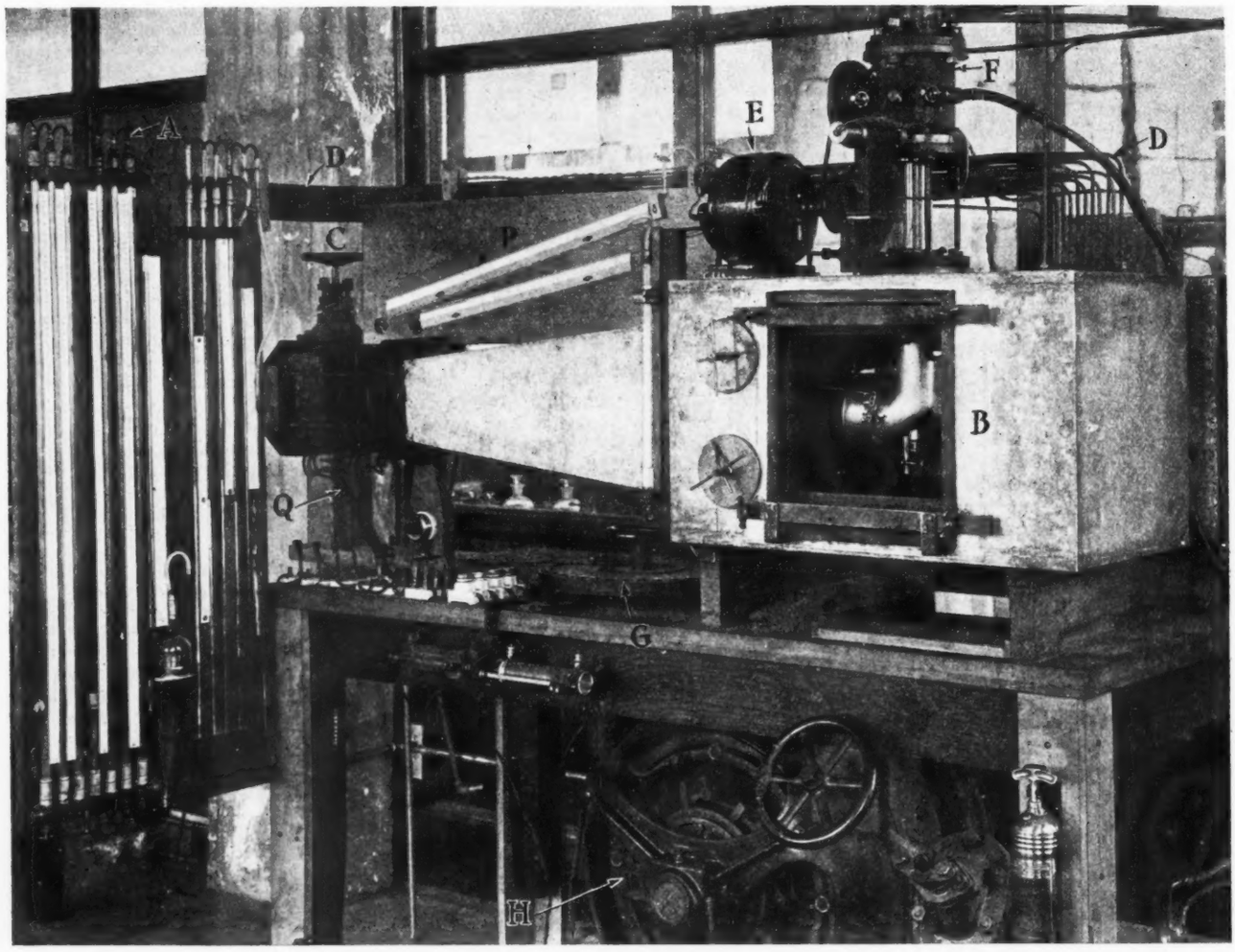
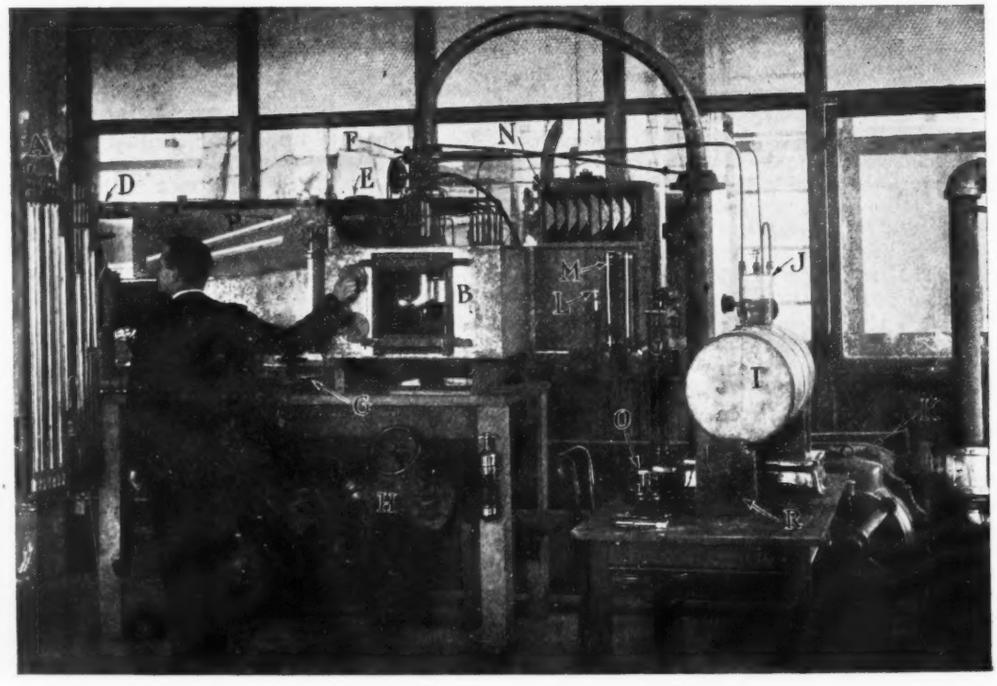
The Altitude Laboratory—Correction

REFERRING to the article on the Altitude Engine Test Laboratory which appeared in the March 6 issue of AUTOMOTIVE INDUSTRIES, by the omission of several words from the sub-head a rather misleading sense was imparted thereto. The sub-head should have read: "Installed at the Bureau of Standards for the National Advisory Committee for Aeronautics."

Bureau of Standards Carbureter Testing Apparatus





Two General Views of Carbureter Test Installation

A, Manometer board; B, Carbureter test chamber; C, Gate valve; D, D, Connections to manometers; E, Electric motor operating pulsator; F, Pulsator; G, Rheostat for air-heating grids; H, Electric motor driving Nash turbine pump; I, Fuel tank; J, Vapor trap; K, Nash turbine pump; L, Rate of pulsation indicator; M, Field rheostat for motor E; N, Set of air-meter orifice plates; O, Stopwatch; P, Inclined manometers connected to opposite sides of air-meter diaphragm; Q, Connections to electric air heater; R, Storage battery for operating stopwatch and electric buzzer

Bureau of Standards Carbureter Test Plant

Designed to Determine Metering Qualities of Different Carbureters Under Varying Conditions of Atmospheric Pressure and Pressure Drop —Pulsating Suction Without Running Engine

By P. M. Heldt

ONE of the test plants built at the Bureau of Standards at the request of and in co-operation with the National Advisory Committee for Aeronautics for the immediate purpose of development work in connection with the Liberty and other airplane engines was designed for making carbureter tests. The object of this plant is to determine the metering qualities of a carbureter under different conditions of temperature, pressure drop and intake pressure, and to do so without having to make engine tests at the same time.

Tests can be made not only at atmospheric pressure, but at pressures as low as one-quarter atmosphere. The importance of this will be realized when it is stated that a reduction in atmospheric density has a powerful effect on the metering qualities, a reduction of 50 per cent in the atmospheric pressure ordinarily entailing an enrichment of the fuel mixture of about 45 per cent.

It must be considered that an engine of the size of the Liberty consumes from 30 to 35 gallons of gasoline per hour, and, counting depreciation of the engine and other expense items, it will be appreciated that a carbureter test with the instrument fitted to an engine involves a great deal of expense. As tests had to be made on different designs of carbureters under numerous different conditions, it was believed that a good deal of expense could be saved and at the same time a setup arranged for that would greatly facilitate the tests by installing a special carbureter test plant. Of course, it is realized that no test is so dependable as one carried out under actual service conditions, and it is admitted that the results obtained generally require checking by a test on an engine in operation, but such a check run is much less onerous than the complete test would be.

THIS is the fifth of a series of articles prepared by Mr. Heldt from the research records of the Bureau of Standards in Washington. Previous articles have covered:

1—*Dry Cell and Storage Batteries*

2—*Tests of Airplane Radiators*

3—*Altitude Engine Test Laboratory*

4—*Tests of Ignition Apparatus*

Additional articles covering other subjects will appear in subsequent issues.—EDITOR.

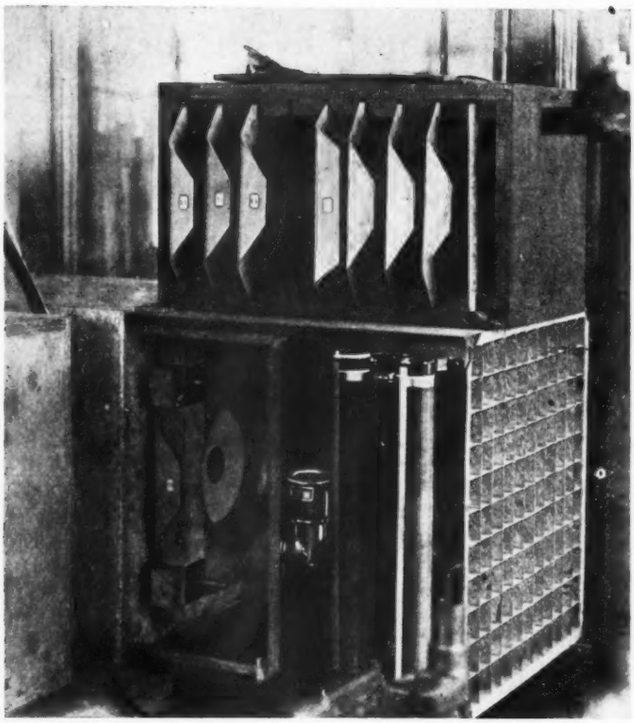
Engine Conditions Closely Approached

Most laboratory metering tests that have been conducted in the past, including the well-known series by Rummel some 10 years ago, were made under the condition of a steady suction. While it is generally believed that the results obtained under these conditions permit of valid conclusions being drawn regarding the action of a carbureter under the influence of the pulsating suction of an engine, it is certainly desirable that the suction effect of an engine should be reproduced as closely as possible in a laboratory test, and this is done in the Bureau of Standards carbureter metering test. The tests can be conducted under air intake pressures as low as one-third atmosphere, and the apparatus is arranged in such a convenient manner that one person can control the test and take all observations. As in an aircraft engine the air is generally heated before entering the carbureter, means are provided in the test plant equipment to raise the temperature of the air above atmospheric temperature to any desired degree. These take the form of electric heating grids in the air passage. The apparatus used comprises the following: An air meter, a throttle valve, an air heater, the carbureter chamber, a pulsator, an air pump, a fuel meter and pressure gage columns.

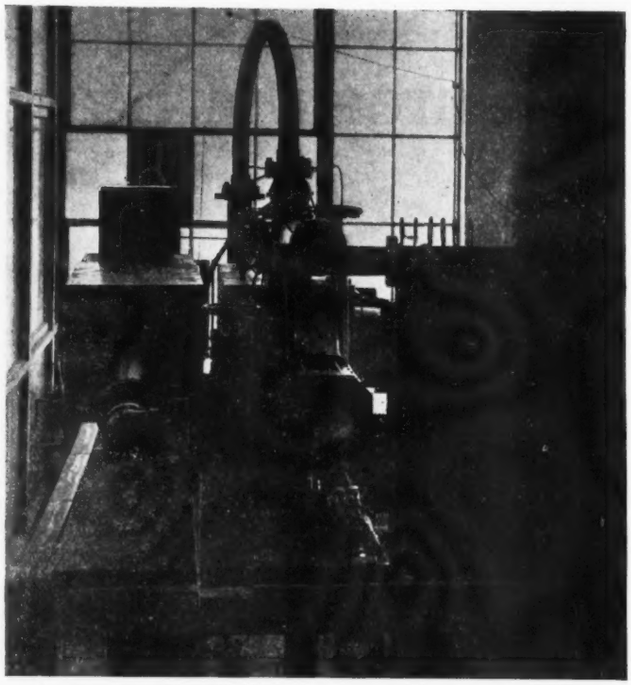
The air first passes through the air meter, then through the throttle valve, over the heating grids into the carbureter chamber, where it enters the carbureter under test. From the carbureter it passes through the pulsator to the blower pump, from which it is discharged into the atmosphere.

The air meter used is of a type first described by R. J. Durley in the *Transactions* of the American Society of Mechanical Engineers and is based on the flow of air through orifices in thin plates. One change that has been made from the Durley arrangement is that the direction of the flow is into instead of out of the chamber. With certain precautions taken in the tests, this has no effect on the accuracy of the measurements.

Means are also provided for protecting the air current as it enters the orifice from disturbance by stray currents in the room, the orifice being provided with an approach passage with a protecting grid. The orifices are bored in steel plates 0.057 in. thick, ranging in size from 3.5 to 0.5 in., by 0.5-in. decrements, with absolutely square edges. In addition there is a 5/16-in. orifice, and a blank plate is used for checking the tightness of the chamber and throttling valve. Rectangular gaskets of pure gum rubber ¼ in. thick form seatings for the orifice plates and insure absolute airtightness even though the plates may be sprung out of shape.

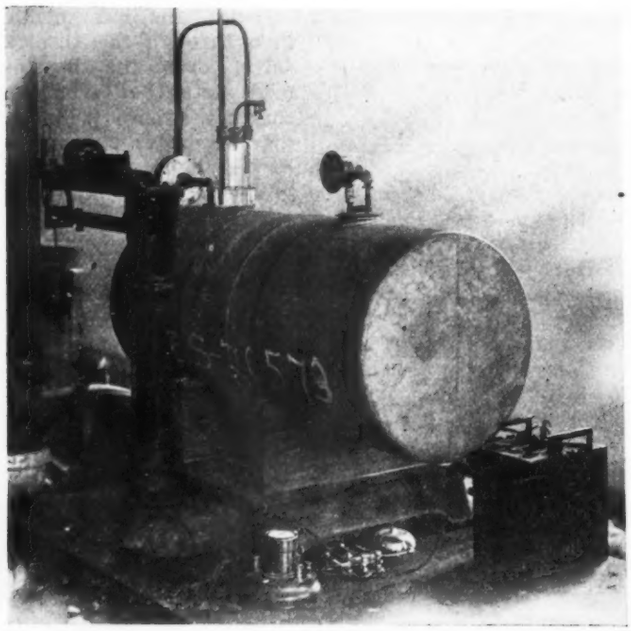


This illustration shows, on top, the set of Durley orifice plates and, below, the air meter. On the side of the air meter box are mounted the rate-of-pulsation indicator and field rheostats for the electric motor



End view of the carbureter test installation showing the air meter at the left, the carbureter test chamber in the center and the back of the manometer board on the right. The 3 in. pipe connection with gate valve from the air meter to the carbureter chamber and the flexible tube from the carbureter to the vacuum pump are plainly shown

Two inclined pressure gages of the pitot tube type are used for determining the pressure drop across the orifice. The tubes are provided with a millimeter scale, and in order to be able to obtain readings directly in inch measures, they are set at such an angle that each division of the scale is equal to a vertical rise of the column of 0.01 in. In this way readings can be made to within a limit of accuracy of plus and minus 0.0025 in. At the left of the carbureter chamber there is a vertical water column with a scale divided into fiftieths of an inch, which can be read through a magnifier, provisions being made to avoid errors due to parallax.



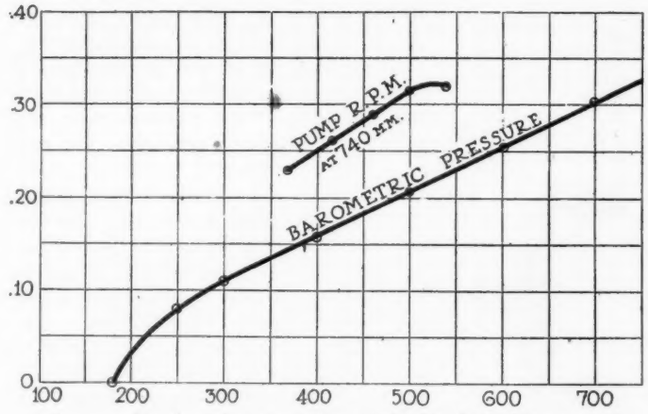
This view shows the fuel tank mounted on a weighing scale with tank pressure gage, vapor trap, stopwatch, electric control and electric buzzer which gives an audible signal when the predetermined weight of fuel has been withdrawn from the tank and the scale beam drops

For controlling the pressure within the carbureter chamber so as to permit of a study of carbureter operation under conditions similar to those encountered at high altitudes, a gate valve is inserted in the air line and connected to the orifice chamber by a piece of 3-in. pipe. The air, after having passed through this gate valve, is drawn through an electric heater consisting of a chamber within which there are frames carrying coils of electric resistance wire. These resistance coils are connected with controlling switches and a rheostat. Some of the resistance coils are connected directly across the 220-volt circuit; two are so arranged that they can have either 110 or 220 volts applied to them, and one of these in addition has a rheostat connected in circuit with it, so that the current flow can be further regulated. By means of the control switches and rheostat the temperature rise of the air can be closely regulated between the limits of 3 deg. and 45 deg. C. above atmospheric temperature, under conditions of maximum air flow. The temperature within the chamber can be read off from a mercurial thermometer mounted just inside the glass door.

Construction of Carbureter Chamber

From the heater the air flows through an approach, shaped like an inverted funnel, into the carbureter chamber, entering the latter through a grid similar to that provided in the approach to the air meter. The purpose of the grid and of the funnel-shaped approach to the carbureter chamber is to prevent the formation of eddy currents, which would be sure to result if the air entered the chamber in a small stream of high velocity.

The carbureter chamber consists of a box made of 2-



Curves showing the operation of the Nash turbine pump used in the carbureter tests

in. boards reinforced along the inside corners by lengths of angle iron. The outside dimensions of the box are 18 x 18 x 30 in. The door comprises a frame of square steel bars, to which is applied a galvanized iron sheathing, the edges of which are turned up at the door opening. The joint between the galvanized iron and steel bars is sealed by means of solder and an airtight joint between the door and the door frame is effected by the use of a rectangular gum rubber gasket. The glass door fitted is of ¾-in. plate glass and is held in place over the opening and against the gasket by a pair of steel bars.

Centrally in the top wall of the chamber there is a circular flange to which any carbureter to be tested can be secured by means of an adapter. To one side of the door opening there is a pair of control shafts which carry adjustable levers inside the chamber, from which connections can be made to the throttle lever and any other control devices with which the carbureter under test may be provided. The hub of the flange on the top of the carbureter chamber extends through the wall of the chamber and on the outside carries a large circular flange. In order to permit of studying the character of the mixture produced by the carbureter, the outlet is made in the form of a glass tube which is held in glands secured by 4 studs. Passing the mixture as it leaves the carbureter through a glass tube enables observation to be made of the quality of the mixture as regards fineness of division of the fuel, of any irregularities in the fuel discharge, of any swirling effect in the mixture stream and of any unequal division of the fuel in the stream or on the walls. The use of a glass tube and outlet pipe also serves as a check on the action of the float mechanism of the carbureter.

Pulsator

Considerable interest attaches to the device employed for creating a pulsating suction in the air passages, referred to as a pulsator, which is located directly above the carbureter, as this is probably the first time that such a device has been used in carbureter tests. This pulsator comprises a cast body with a rectangular passage for the fuel mixture. A butterfly throttle valve is located in this passage. Two opposite walls at the rectangular passage consist of plates of spring bronze, which are normally flat. These spring bronze plates are located directly over the throttle valve and permit of varying the effective area of the passage at the valve.

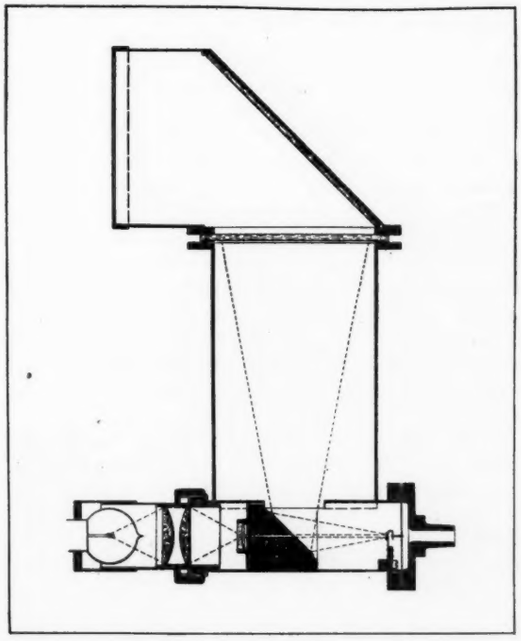
Pulsation of the suction is produced by rotating the valve by means of a 1/6-hp. electric motor which is mounted on top of the carbureter chamber and drives the throttle valve by belt. Stepped pulleys permit of varying the speed of the pulsator valve, and further speed control may be effected by means of resistances in the motor field circuit. In this way the rate of pulsation can be varied between the limits of 600 and 4000 per minute, which corresponds to a range of engine speed of 300 to 2100 r.p.m. for 4-cylinder engines and 400 to 2800 r.p.m. for engines in which one carbureter supplies three cylinders. A tachometer serves to indicate the speed of the pulsator valve. This is of the type designed to be fitted to the camshaft of an engine, and its indications are always equal to twice the number of revolutions per minute at which it is driven. As the throttle valve produces two pulsations per revolution, the tachometer indicates directly the pulsations per minute.

Optical Indicator

The amplitude of the pulsations can be varied by means of screws pressing against the spring bronze plates and forcing them more or less toward the throttle sweep. In this way it is possible to closely reproduce the pulsating suction characteristics of any engine in which explosions follow one another at equal intervals. Indications of the magnitude of pressure fluctuation are given by a simple form of optical indicator provided with a graduated screen. A line of light appears on this screen, the ends of which represent the pressure limits.

For creating the suction on the carbureter, use is made of a Nash vacuum pump which connects to the pulsator by means of a flexible metallic tube and which discharges outside the laboratory. Adjacent to the pulsator outlet, a throttling opening and trap is inserted in the line. This serves to prevent any effect upon the carbureter action of possible resonance in the flexible tube due to the pulsator action, and also to dispose of any liquid in the mixture above the pulsator, especially at low air velocities, which is passed from here directly to the pump intake (through a ⅜-in. inclined pipe).

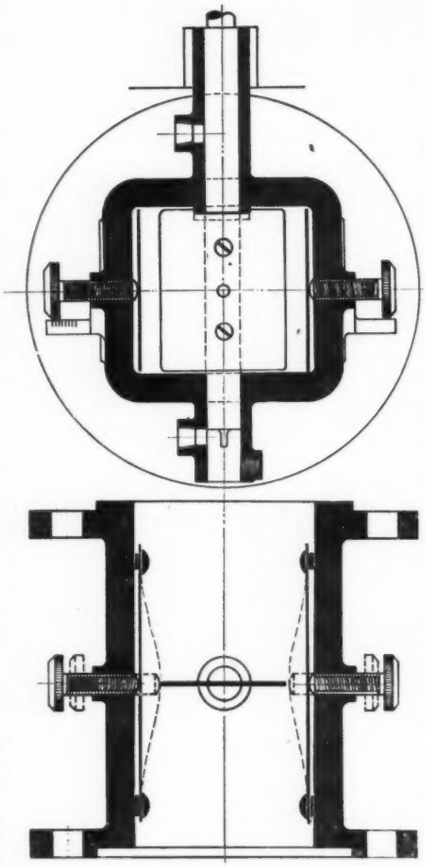
The fuel delivered by the carbureter is measured by weighing. From a 30-gal. tank on a platform scale it is



In the carbureter tests a pulsating suction corresponding to the strokes of a running engine is created by means of a vacuum pump. The magnitude of these pressure fluctuations is noted on the screen of the optical indicator shown above. A beam of light is reflected from a mirror, at the lower right of the device, connected to a diaphragm

forced under pressure to the carbureter float chamber, a gage on the tank indicating the pressure on the fuel (which is usually maintained at 2 lb. per sq. in. by means of a regulating valve in the pressure line). The pressure here referred to is the difference in pressure on the fuel in the tank and that in the carbureter chamber. Beyond the pressure regulating valve there is a vapor trap in the line, mounted on top of the tank, and thence the fuel passes through a copper tube to a valve and fitting in the top wall of the carbureter chamber, from which a length of airplane fuel hose connects to the carbureter.

The beam of the fuel-weighing scale is provided with a mercury contact device by means of which an electric circuit is completed which controls the stopping and starting of a stopwatch, and also the electric circuit of an annunciator, so that an audible signal is given to the operator when the run begins and ends. As the stopwatch is started and stopped automatically, the human equation is entirely eliminated in the determination of the fuel delivery. This method has the further advantages that it relieves the operator of the necessity of minding the fuel scales, leaving him free to devote all his attention to the other indicating devices and to the control of the carbureter.



Construction of rectangular pulsator and butterfly valve and plates for varying effective area of the passage

Twelve pressure gages are made use of in connection with this test installation. These extend into the carbureter chamber, the connections being made at the door, where union fittings are soldered into the galvanized iron sheathing, the connections being made by copper tube outside the chamber and by rubber hose inside. The scales of the water columns are so arranged that they can be adjusted vertically as a unit, in accordance with the level in the header from which the columns draw their water. This permits of resetting the scales during the run to allow for the displacement of the zero as water is transferred from the header to the columns. However, the tank is of such size that even if three of the columns should be in use simultaneously and should be entirely full of water, the error due to the change in the zero position would be less than 1 per cent. In addition to the six columns referred to and the main barometer for indicating the chamber pressures, there are mounted on the board a pair of mercury U tubes and a supplementary U-tube barometer. By means of T fittings and tubing within the chamber the various columns can be interconnected in different combinations.

The air pump is driven by a 25-hp. shunt motor which is provided with controlling resistances for the field circuit. When the pump is in operation the rate of air flow through the carbureter depends upon the position of the carbureter throttle, the position of the throttling valve adjacent to the air heater and the position of the gate valve on the pump intake. The gate valve determines the depression in the carbureter outlet, and hence the rate of air flow through the carbureter, while the throttling valve adjacent to the air heater exerts an influence upon the pressure, and consequently upon the density of the air in the carbureter chamber, and in this way has an effect upon the rate of air flow through the carbureter.

The chief object of the carbureter test plant is to determine quickly the ratio of air to fuel passed under any given conditions. First of all the outfit must be adjusted to pass the required quantity of air under conditions of predetermined atmospheric and carbureter outlet pressures. The first step when such a test is to be made is to select the proper air meter orifice and put it in position. This selection is facilitated by the use of graphs which have been prepared for each of the orifices regularly used, showing the amount of air in pounds passed per second as a function of the pressure difference. Next, the pump intake by-pass and the throttling valve are adjusted to give the required indication of the pressure gage, showing the orifice pressure at the predetermined pressure in the carbureter chamber. With a given setting of the throttling valve, subsequent adjustment of either the orifice pressure or the carbureter chamber pressure will automatically entail readjustment of the other. Then the carbureter throttle is adjusted to give the carbureter outlet pressure corresponding to the predetermined chamber pressure and drop in the carbureter.

The rate of air flow through the carbureter and conditions of inlet and outlet pressure being now fixed, the weights on the fuel scale are adjusted so the beam is about to drop. As a result of withdrawal of fuel from the tank by the carbureter, the beam soon drops and starts the stopwatch. Then a weight is removed from the scale corresponding to the amount of fuel it is desired to pass through during the test, and when this has been withdrawn from the tank the scale again drops, closing the electric contact and stopping the stopwatch. While the run is on, the operator observes and records the indications of the thermometric apparatus, the pressure gages, tachometer, pulsation indicator, etc. At the end of the run he has the amount of the air and fuel delivered and the time occupied in passing these quantities of air and fuel. This completes the run.

So far most of the development work that has been carried out in this carbureter test plant has been with large size aircraft engines which had been tested previously, so that the rates of air and fuel flow were rather closely known in advance. However, the plant has been designed to permit of a wide range of adjustment, a fact which will render it all the more useful now that lines of automotive work other than aircraft development will regain their pre-war importance.

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THE Derbyshire (England) oil boring operations are said to have met with encouraging success recently. At Hardstoft much water has been met with, which has delayed progress, but several gushes of gas have been encountered which are associated with the presence of oil. At Brimington, following repeated gushes of gas, the first traces of oil have been encountered. It is of the rough character known as "farmers' oil," but gives off an odor of paraffin. Receptacles for conserving oil, if it is tapped in quantity, are being arranged on the spot.

New Golden, Belknap & Swartz Truck and Tractor Engine

Will Enter Production in March with L-Head, 3¾ by 5-In. Powerplant, Adapted to Low-Grade Fuel — Built for Truck and Tractor Service

THE Golden, Belknap & Swartz Co., Detroit, will be in production toward the end of this month on a new truck and tractor engine. This is a 3¾ in. by 5 in., four-cylinder model, known as the AA, designed to handle low-grade fuel and is a new product in every respect, arranged to have the most advanced practice in detail design.

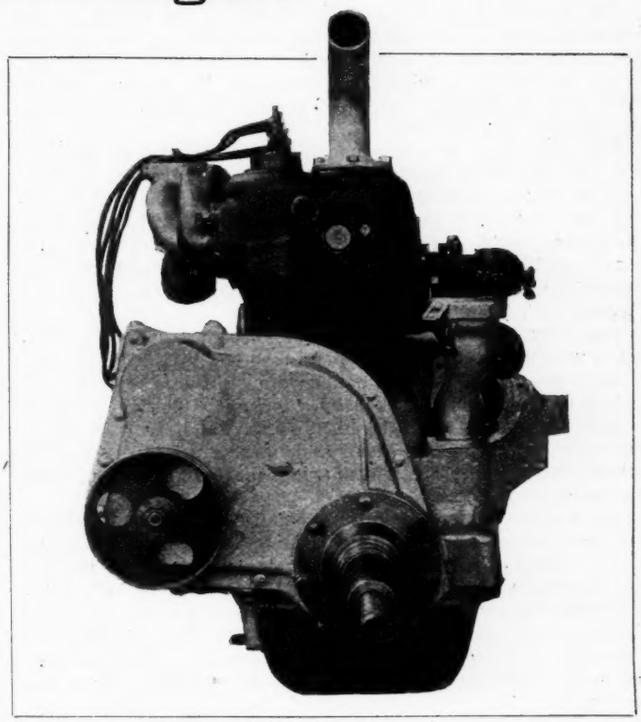
The engine is laid out generally to accommodate itself to the demands of truck and tractor manufacturers and to fit the requirements of their particular chassis. The carbureter, for example, can be mounted on the left or right side of the engine. Thermo-syphon or pump water circulation can be used and battery or magneto ignition is suitable, driving facilities being arranged to take care of either.

If the engine is used in tractor service, an oil cooler can be fitted, and if it is desired to mount a governor, there is a vertical shaft with a slotted end to take the governor drive and a flange face upon which to mount it. The engine is a fixed-head type with removable water header. Both halves of the crankcase are aluminum and the cylinders are cast in a block of gray iron.

The pistons are the three-ring type, with oil relief holes drilled circumferentially below the lower ring to prevent oil pumping into the cylinders.

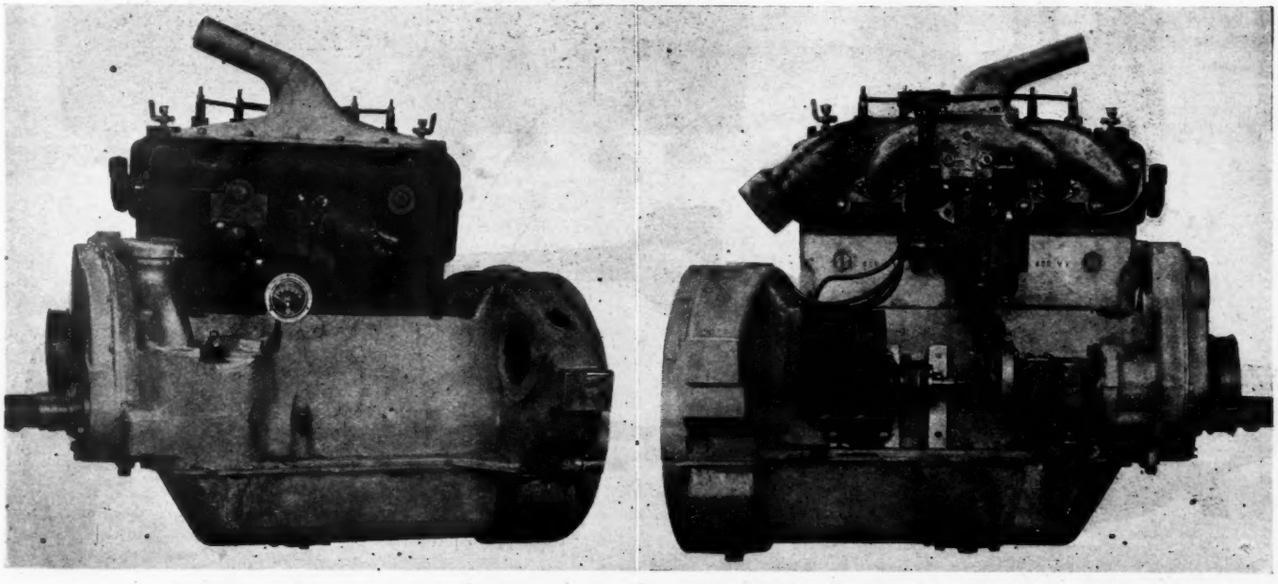
There are also two grooves at the bottom of the piston skirt which act as oil retainers. The piston pin is anchored in the boss and the weight of the piston complete with the wrist pin and rings is 3 lb. 1 oz. The length of the piston is 3¾ in. The wrist pin bearing is 1½ in. in width and 1 in. in diameter.

The connecting-rods are 10¼ in. in length, center to center.



Front end of new Golden, Belknap & Swartz 3¾ by 5 in. truck and tractor engine

They are machined quite closely for light weight. The weight of the connecting-rods is 2 lb. 4 oz. They are provided with lower bearings, 2 3/16 in. in width and 1⅞ in. in diameter. The crankshaft is 2¼ in. in diameter and is carried on three main bearings, the front being 3 in. in length, the center 2½ in., and the rear 3 in. Both the main bearings and the connecting-rod bearings are bronze-back, babbitt lined.



Left side of Golden, Belknap & Swartz engine, showing carbureter mounted on left side and detachable flange cover for thermo-syphon cooling; and right side, with carbureter mounted for hot spot manifold and magneto

The three bearings for the camshaft are die-cast babbitt. The main and connecting-rod bearings have the new Muzzy Lyon babbitt adjustment in place of shims. This is a solid piece of babbitt metal of the thickness of the ordinary group of shims, but has the advantage that it can be inserted beyond the inside of the bearing and then burnished out to form a part of the true bearing surface, eliminating the ordinary outlet for the oil which exists in the shimmed bearing.

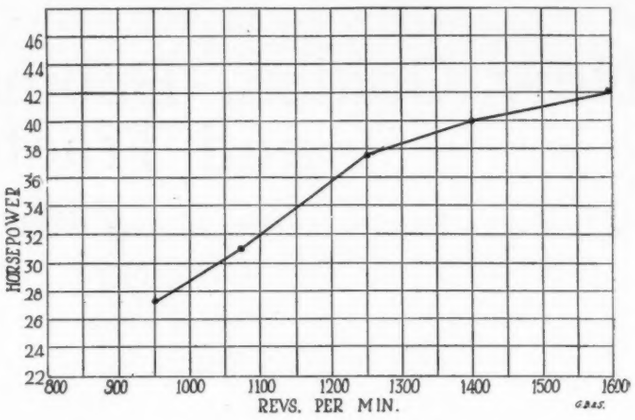
The babbitt is undercut at the center of the length of the bearing, so as to line up with the oil groove in the bearing, permitting the oil to have free flow at the bearing surface. When necessary to adjust the bearings, the babbitt can be filed down to any amount, thus permitting of very accurate settings on the bearings.

The main bearings are supported in the crankcase, the center bearing being very heavily ribbed to give the desired rigidity and continuity of alignment. Each of the main bearing caps is held in place by four alloy steel stub bolts with castellated nuts, cotter-pinned into position. The timing gears are helically cut and are steel against semi-steel. The camshaft is on the right side of the engine and is an integral forging with large bearings.

The valves are driven through mushroom tappets, the tappet guides being locked by spiders bolted to the crankcase.

Adjustment is made by means of a stud screwed into the end of the tappet and locked by a locknut. The valves have a port diameter of 1 11/16 in., and have a lift of 23/64 in. The valve passages are clear and of ample size, as will be noted from the illustration showing the cylinder block with the valve ports exposed.

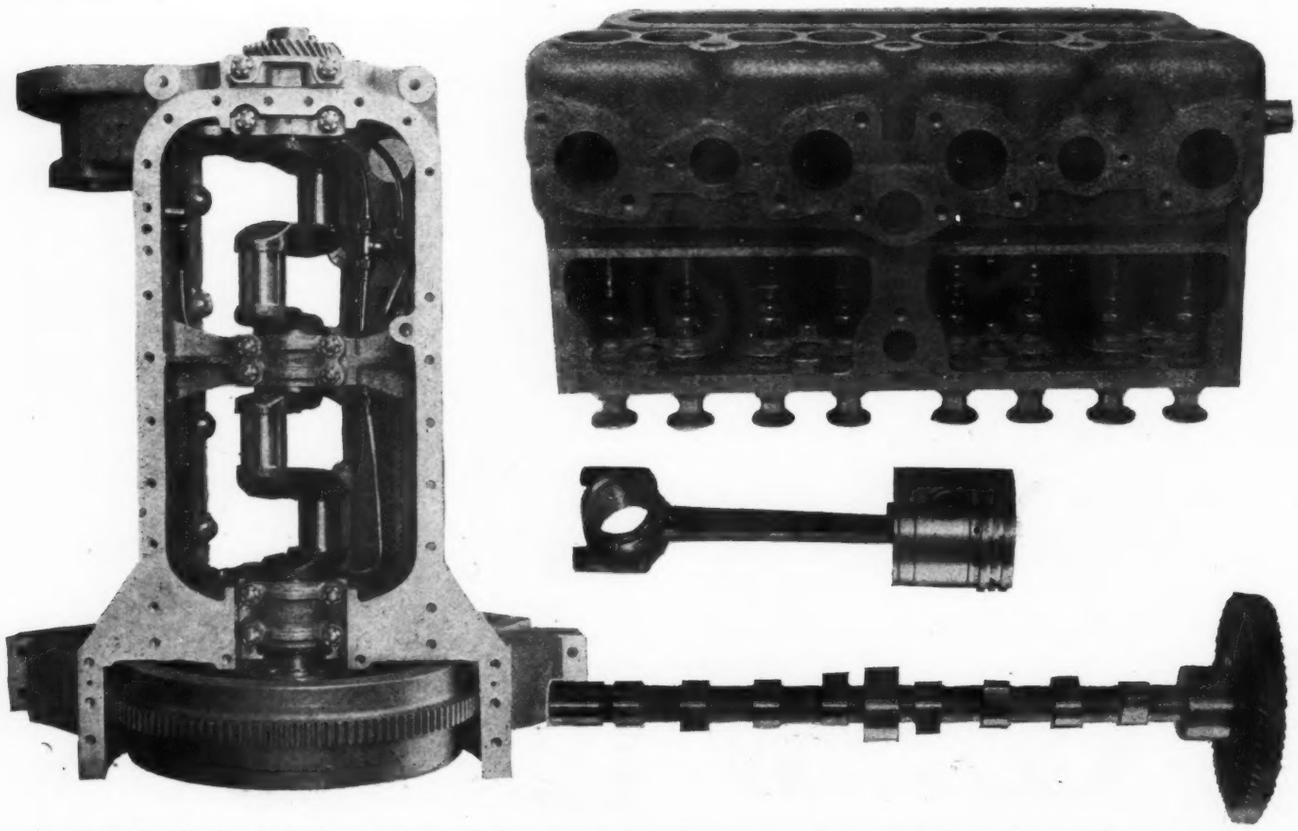
The course of the intake gases depends upon the side of the engine upon which the carbureter is mounted. When the mounting is as shown in the illustration herewith, the hot spot type of manifold is used with the intake partially integral with the exhaust, securing the desired preheating effect. The hot spot construction is used even if the carbureter is mounted on the opposite side, as the store is so arranged that the intake gases are drawn from the store between the cylinder blocks.



Horsepower curve of new Golden, Belknap & Swartz 3¾ by 5 in. truck and tractor engine

Lubrication is by full pressure system, with no splash. The oil pump is driven off the water pump shaft and is a gear type. It is mounted on the exterior and can thus be readily removed for inspection. Pressure can be regulated to suit requirements. There is provision for mounting a pressure gage on the dash, this gage being shown closely connected to the engine in the left-side view. The oil relief or pressure regulation is external, being readily made with a screwdriver and wrench. This adjustment is located on the outside of the engine at the point at which the oil filler neck leaves the crankcase.

Under ordinary conditions the oil is fed under a pressure of 15 lb. per sq. in. The oil leads are self-contained, taking the oil from the pump direct to each of the three main bearings, and another lead for pressure passes through the pressure gage. The crankshaft is drilled through the cheeks to



Cylinder block of Golden, Belknap & Swartz truck and tractor engine and piston and connecting rod and camshaft assemblies

the crank pin, which is also drilled to feed the oil to the lower connecting-rod bearing. As the oil is fed under pressure and since it is supplied in superfluous quantities, there is a marked spray off the lower ends of the connecting-rods which lubricates the internal walls of the cylinder.

In ordinary practice, the engine will be cooled by pump circulation. The water pump and the magneto are driven off the same shaft when magneto ignition is used, and this same longitudinal shaft also provides a drive for the oil pump, as well as for the governor when fitted. A study of the water outlet header will show that this is suitable for either pump or thermo-syphon circulation. Should the thermo-syphon cooling be used, the cap flange on the left side of the engine is removed and the water connection made here instead of at the pump.

No accessories are furnished with the engine. The mounting is designed for three-point suspension, and the overall dimensions are 34 1/16 in. in length, 31 in. in height and 23⅛ in. in width. The engine is produced with a No. 3 S. A. E. bell housing as standard, the starting motor mounting being in this bell housing. There is a generator mounting on the rear of the timing gear housing on the right side of the engine, if the magneto is used, or the generator may be mounted on the shelf in which the magneto is shown in the accompanying illustration. These various locations for mounting different accessories or auxiliary units give the engine a very elastic make-up.

The general power characteristics of the engine as shown from tests on the fan dynamometer give 42 hp. at 1600 r.p.m., with the maximum torque at 800 r.p.m. The governed speed is 1400 r.p.m. The weight of the engine without ignition system or carbureter is 410 lb.

British Papers on Motorcycle Design

ABOUT a year ago there was considerable discussion in the British press in regard to the need of some method of ventilating and discussing the difficulties with which designers of motorcycles were faced. The matter was immediately considered by the Council of the Institution of Automobile Engineers, and after a conference with technical representatives, of some of the motorcycle manufacturing firms, the Institution undertook to arrange meetings to deal specially with points in connection with motorcycle design, provided that sufficient support was forthcoming from those interested in that branch of the industry. A large number of motorcycle engineers have since joined the Institution, we are informed.

Two meetings were arranged in Birmingham, to form part of the regular Institution session, and the papers for these meetings deal specifically with points connected with the design of motorcycles. The first paper, which was read at the Birmingham Chamber of Commerce on February 20, by D. S. Heather, was entitled "A Survey of Current Motorcycle Design."

Mr. Heather wrote as a rider, rather than as a designer of motorcycles, and this was perhaps rather fortunate, for it is believed that it is just this point of view that the motorcycle manufacturers often lack. The criticism made by Mr. Heather was not entirely uninformed, however, as he has been connected with the motor car side of the industry for some time.

The second paper on the subject will be read on March 20, at the same place, by Eric Caudwell, and is announced to be composed chiefly of constructive criticism.

New Organization of the United States Air Service

WASHINGTON, March 17—Maj.-Gen. Chas. P. Menoher, Director of Air Service, has announced a new organization as follows:

Executive Staff

Executive Officer, Col. Milton F. Davis, A.S., A.
First Assistant Executive, Col. William E. Gillmore, A.S., A.
Second Assistant Executive, Maj. Horace M. Hickam, A.S., A.
Third Assistant Executive, Brig. Gen. William Mitchell, U. S. A.
Fourth Assistant Executive, Lt. Col. William F. Pearson, A.S., A.

Technical Advisory Staff

Supply

Chief, Air Service Property, Lt. Col. Augustine W. Robins, A.S., A.
Chief, Air Service Procurement, Col. Chalmers G. Hall, A.S., A.
Chief, Air Service Materials Inspection, Lt. Col. George W. Mixter, A.S., A.P.
Chief, Air Service Finance, Lt. Col. Alex. C. Downey, A.S., A.P.
Chief, Air Service Aeronautical Engineering, Col. Thurman H. Bane, A.S., A.

Training and Operations

Chief, Air Service Training (Detail to be announced later).
Chief, Air Service Operations, Lt. Col. Lewis H. Brereton, A.S., A.
Chief, Air Service Gunnery, Lt. Col. Harold E. Hartney, A.S., A.
Chief, Air Service Communications, Col. Clarence C. Culver, A.S., A.
Chief Air Service Balloons and Airships, Col. Charles DeF. Chandler, A.S., A.

Administrative Staff

Chief, Air Service Personnel, Lt. Col. Rush B. Lincoln, A.S., A.
Chief, Air Service Inspector, Lt. Col. Frank M. Andrews, A.S., A.
Chief Surgeon, Air Service, Col. Albert E. Truby, M.C.

The following named officers have been designated as an Advisory Board, Air Service:

Col. Walter G. Kilner, M.A., A.S.A.,
Col. Arthur L. Fuller, A.S.A.,
Col. Henry C. Pratt, A.S.A.,
Lt. Col. George B. Hunter, A.S.A.,
Lt. Col. Henry W. Harms, J.M.A., A.S.A.,
Maj. Charles R. Cameron, A.S.A., Secretary.

and the following named detailed for duty in the Office of the Director of Air Service, as indicated:

Assistant to Executive Officer, Lt. Col. Oscar Westover, A.S., A.P.
Assistant to Second Assistant Executive, Maj. John B. Reynolds, A.S.A.
Assistant to Third Assistant Executive, Col. Thomas DeWitt Milling, M.A., A.S.A.
Assistant to Fourth Assistant Executive, Maj. Walter H. Frank, J.M.A., A.S.A.
Assistant to Fourth Assistant Executive, Maj. Raycroft Walsh, J.M.A., A.S.A.
Assistant to Chief, Air Service Materials Inspection, Lt. Col. John D. Reardan, A.S., A.P.
Assistant to Chief, Air Service Finance, Lt. Col. Jacob E. Fickel, J.M.A., A.S.A.
Assistant to Chief, Air Service Finance, Lt. Col. William C. McChord, J.M.A., A.S.A.
Assistant to Chief, Air Service Aeronautical Engineering, Lt. Col. Byron Q. Jones, M.A., A.S.A.
Assistant to Chief, Air Service Training, Lt. Col. Herbert A. Dargue, M.A., A.S.A.
Assistant to Chief, Air Service Personnel, Lt. Col. Hollis C. Clark, A.S., A.P.
Legal Advisor to Director of Air Service, Maj. J. Gowan Roper, J.A.

The following chart explains the various functions of the Executive Staff:

Director of Air Service

Advisory Board ... { Executive Officer, Col. M. F. Davis } Foreign Representation (to be announced later)

Col. W. G. Kilner.
Col. A. L. Fuller.
Col. H. C. Pratt.
Lt. Col. G. B. Hunter.
Lt. Col. H. W. Harms.
Maj. C. R. Cameron.

EXECUTIVE STAFF

1st Asst. Executive, Col. W. E. Gillmore.

Technical Advisory Staff, supply:
Chief, A. S. Property, Lt. Col. A. W. Robins.
Chief, A. S. Procurement, Col. C. G. Hall.
Chief, A. S. Materials Inspection, Lt. Col. A. C. Downey.
Chief, A. S. Aero. Engineers, Col. T. H. Bane.

2nd Asst. Executive, Maj. H. M. Hickam. Information, Statistics, Publicity.

3rd Asst. Executive, Brig. Gen. William Mitchell. Tech. Advisory Staff, Training and Operations,
Chief, A. S. Training (to be announced later).
Chief, A. S. Operations, Lt. Col. L. H. Brereton.
Chief, A. S. Gunnery, Lt. Col. H. E. Hartney.
Chief, A. S. Communications, Col. C. C. Culver.
Chief, A. S. Balloons and Airships, Col. C. DeF. Chandler.

4th Asst. Executive, Lt. Col. W. F. Pearson.

Administrative Staff:
Chief, A. S. Personnel, Col. R. B. Lincoln.
Chief, A. S. Inspector, Lt. Col. F. M. Andrews.
Chief Surgeon, A. S., Col. A. E. Truby, M.C.
Routine Executive, A. S. Functions.

Walker Automatic Gear Tooth Rounding Machine

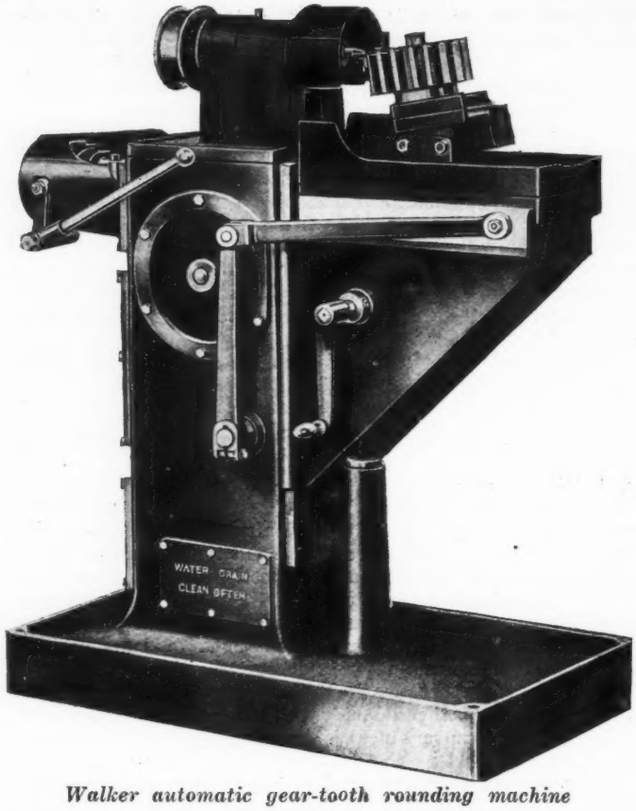
Can Be Set to Round Meshing Edges, or to Remove Burrs Left by Cutters or Hobs

ROUNDING the edges of teeth of sliding meshing gears, such as are used in gearsets, presents a peculiar problem in machining which necessitates the use of a special machine. The newest of these has been brought out by the Charles H. Walker Machinery Co., Detroit. This machine can be used either for rounding the meshing gear edges or it can be so set up as to efficiently remove the burrs left by the cutter or hob on spur gears, straight and spiral bevel gears, helical gears and worm wheels.

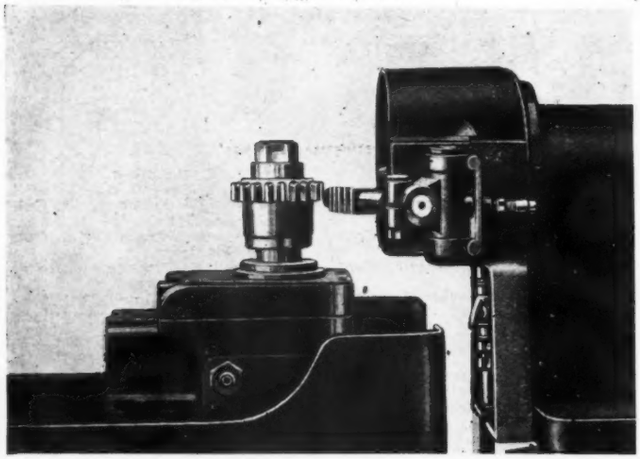
The machine has capacity for any gear up to 30 in. diameter by 12 in. face and of any standard or special pitch from 20 to 2½ pitch and of any number of teeth. When used for rounding purposes the machine will round the entire end of the tooth for 180 deg. at any desired radius. In rounding the tooth the cutter takes off the surplus metal at the root of the tooth, thus freeing the gear of burrs and eliminating the filing work sometimes necessary.

The gear is held rigidly during the cutting operation. The cutter starts at one side of the tooth and works around it, finishing on the other side. Owing to the fact that the gear is held rigidly during the cutting operation, there is no backlash and the cutter cuts both sides of the tooth equally. There is a quick return movement to bring the cutter back to its starting position rapidly. While the cutter is going back to starting position the table is moved out and in, bringing the next tooth to be rounded in mesh with the indexing rack, thus automatically indexing and centering the tooth in correct relation to the cutter.

The indexing rack is cut with teeth of the same pitch as the gear to be rounded. It meshes a trifle below the top of the gear so as not to interfere with the cutter, and due to its solid mesh the indexing rack holds the tooth being cut rigidly throughout the cutting operation. The indexing method is simple, getting away from change gears, ratchets and other devices.



Walker automatic gear-tooth rounding machine



Indexing mechanism, showing how indexing rack meshes with gear below its top surface

Owing to the automatic operation of the machine, one operator can handle a number, depending on the class of work. Ordinarily, an operator can handle three to four machines on a production basis. The cutter spindle is driven by an independent shaft and is mounted in a double eccentric, allowing the spindle to be offset to accommodate gears up to 2½ pitch.

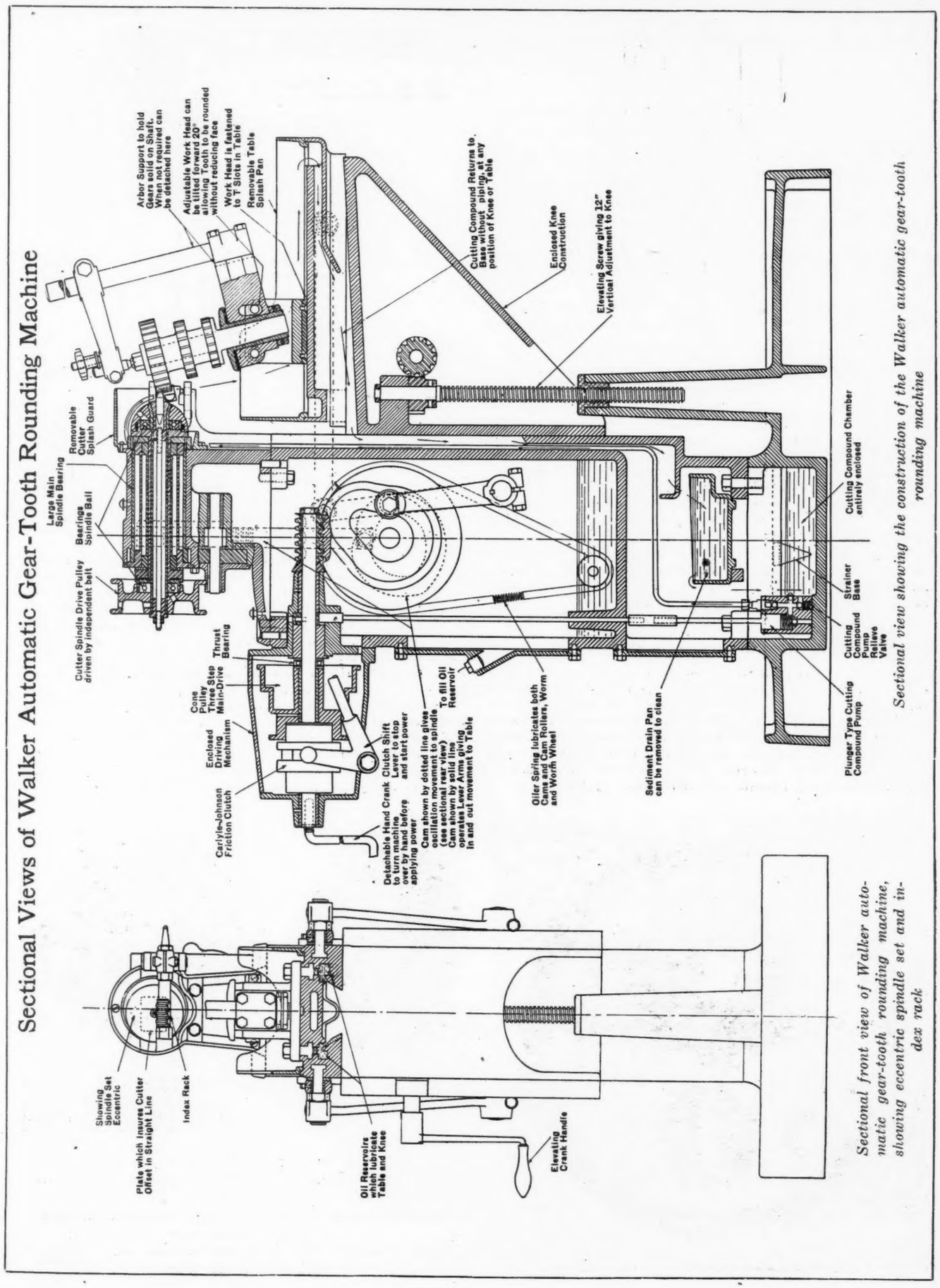
The driving mechanism is enclosed and includes a three-step cone pulley. There is a clutch shift lever to stop and start. The machine camshaft is driven from the powershaft by a worm drive, and the camshaft is lubricated by a belt carrying an oiler spring which picks up oil out of the reservoir in the sump below the camshaft in the main body of the machine. This oiler spring lubricates both the cams and cam rollers, worm and worm wheel. The drive from the camshaft controls the operation of the table and also the oscillation of the cutter.

For the motion of the table the cam operates through lever arms which are shown in the exterior view of the machine, and for the oscillation of the cutter the motion is imparted by a rack which is operated from the cam. The pinion operated by the rack is solid on the same shaft as the gear wheel, which meshes with the spindle sleeve. The upward motion of the rack revolves the pinion half way around, causing the entire spindle head to operate. The cam is so shaped that a quick-return movement is given to bring the cutter back to its original position.

The machine is fully equipped with the customary adjustments. The elevating screw gives 12 in. vertical adjustment to the knee. The arbor support will hold the gears in any desired position, there being an adjustable work head which can be tilted forward 20 deg., allowing the tooth to be rounded without reducing its face, the angle of course being set to conform with the pressure angle of the teeth.

The work head is fastened to T slots in the table and there is a removable table splash pan. The cutting compound is carried in the base of the machine and is pumped by a plunger pump, operated by an eccentric off the powershaft. The cutting compound is carried to the work and guided by means of a removable cutter splash guard to the table splash

Sectional Views of Walker Automatic Gear-Tooth Rounding Machine


Arbor Support to hold Gears solid on Shaft. When not required can be detached here
Adjustable Work Head can be tilted forward 20° allowing Tooth to be rounded without reducing face
Work Head is fastened to T Slots in Table
Removable Table Splash Pan
Cutting Compound Returns to Base without piping, at any position of Knee or Table
Enclosed Knee Construction
Elevating Screw giving 12" Vertical Adjustment to Knee
Removable Cutter Splash Guard
Large Main Spindle Bearing
Bearings Spindle Ball
Cutter Spindle Drive Pulley driven by independent belt
Thrust Bearing
Cone Pulley Three Step Main-Drive
Enclosed Driving Mechanism
Carlyle-Johnson Friction Clutch
Detachable Hand Crank to turn machine over by hand before applying power
Clutch Shift Lever to stop and start power
Cam shown by dotted line gives oscillation movement to spindle (see sectional rear view) Cam shown by solid line operates Lever Arms giving in and out movement to Table
To fill Oil Reservoir
Oiler Spring lubricates both Cams and Cam Rollers, Worm and Worm Wheel
Sediment Drain Pan can be removed to clean
Cutting Compound Chamber entirely enclosed
Strainer Base
Cutting Compound Pump Relieve Valve
Plunger Type Cutting Compound Pump
Showing Spindle Set Eccentric
Plate which insures Cutter Offset in Straight Line
Index Rack
Oil Reservoirs which lubricate Table and Knee
Elevating Crank Handle

Sectional view showing the construction of the Walker automatic gear-tooth rounding machine

Sectional front view of Walker automatic gear-tooth rounding machine, showing eccentric spindle set and index rack

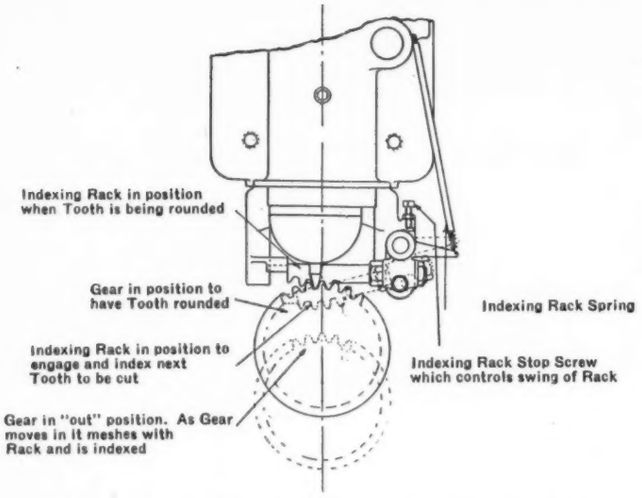

Indexing Rack in position when Tooth is being rounded
Gear in position to have Tooth rounded
Indexing Rack Spring
Indexing Rack in position to engage and index next Tooth to be cut
Indexing Rack Stop Screw which controls swing of Rack
Gear in "out" position. As Gear moves in it meshes with Rack and is indexed

Diagram of indexing mechanism, showing cutter and starting position

pan, draining back to the base without piping at any position of the knee or table, owing to the enclosed knee construction.

The cutters are made with the same angle as the pressure angle of the tooth. The point of the cutter is cut off as much as possible, so that the cutter just fits in the tooth space. Therefore, the larger the pitch the larger and stubbier the cutter. The end of the cutter acts as an end mill and removes the surplus metal at the root of the tooth.

The present machine is based on the machine designed in 1912 by Fred Heal of the Detroit Standard Gear Co., Detroit. All of the patent rights on this type of machine have been assigned to the Charles H. Walker Machinery Co.

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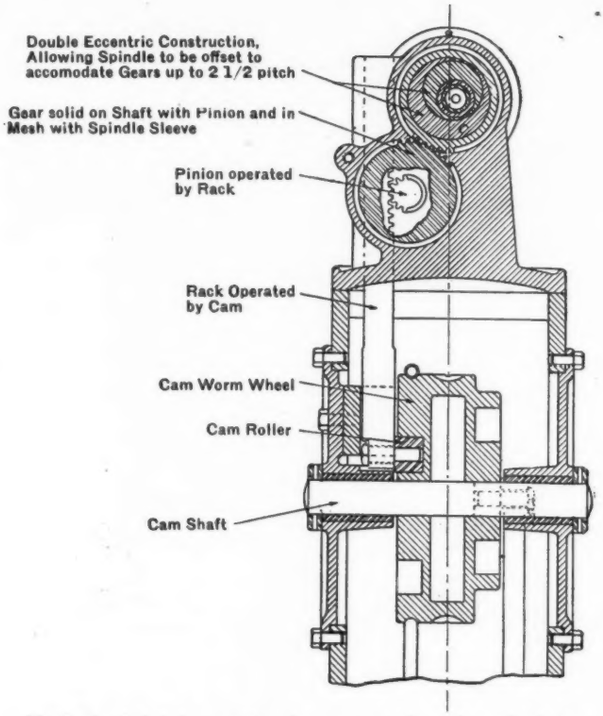
Norwegian Grinding Wheels

A NORWEGIAN company in Arendal is supplying grinding wheels produced in electric furnaces. Their "Sika" wheels, suitable for castings and coarse work, are made of fused carbide o fsilicon (SiC.), which produces gray-green crystals of great hardness, generally known as "carborundum." Their "Durabit" wheels (suitable for grinding hard steel) are made of aluminum oxide ($A1_2O_3$), known as artificial corundum, obtained by fusing bauxite into red-brown crystals.

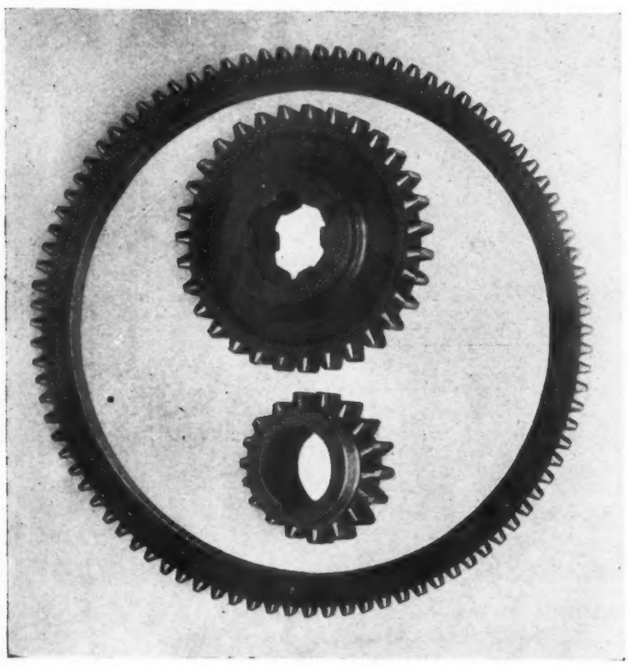

Double Eccentric Construction, Allowing Spindle to be offset to accomodate Gears up to 2 1/2 pitch
Gear solid on Shaft with Pinion and in Mesh with Spindle Sleeve
Pinion operated by Rack
Rack Operated by Cam
Cam Worm Wheel
Cam Roller
Cam Shaft

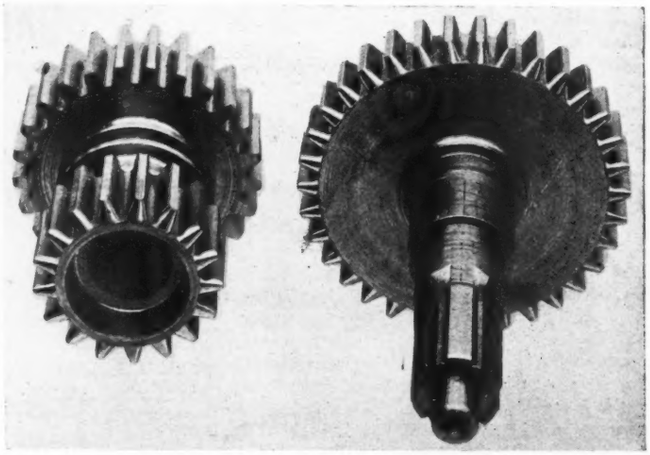
Method of driving cutter by means of rack and pinion

The crystals are ground to powder and sorted mechanically, ranging from No. 10, which is the coarsest, to No. 250, which is the finest polishing "flour." To produce grinding wheels, the powders are generally mixed with some binding medium as clay having a melting point of 2200 to 2500 deg. F. The discs are first formed in hydraulic presses, then exposed to the above temperature in an electric furnace, where the clay fuses and the whole becomes a hard, homogeneous mass. The hardness is proportionate to the quantity of clay used.

Shellac or water glass is also used as binding materials, in which case the temperature varies from 350 to 550 deg. F.

All wheels are provided with lead bosses and turned in the lathe after completion so as to be accurately centered. The elastic shellac wheels are turned with diamond tools, the others by rotating conical steel cutters.—*Teknisk Ukeblad.*





Left—93-tooth 7-9 pitch flywheel ring gear rounded in 3 min. 20 sec. The 32-tooth 6-8 pitch gear is rounded in 1 min. 6 sec.

Center—The 17-tooth 5 pitch cluster gear herewith was rounded in 1 min. 8 sec.

Right—This 33-tooth 6 pitch gear was rounded in 2 min. 10 sec. on the Walker machine

On Proportioning Engine Bearings*

An Analysis of the Crank-Bearing Loads in a Four-Cylinder, Three-Bearing Truck Engine Under Different Conditions of Operation

By Otto M. Burkhardt

THERE exists considerable uncertainty among designers regarding the proper proportions for crankshaft bearings. The writer therefore has worked out a method for determining these proportions, based on the principle that the necessary dimensions are a function of the load the bearing has to carry. A separate analysis is required for each type of engine, and in this paper we will confine ourselves to the most popular of all types, the four-cylinder four-stroke engine. The analysis will be further limited by assuming the engine to be intended for motor truck work.

First of all, it is necessary to ascertain the bearing loads pertaining to the four limiting conditions of operation:

1—Engine running light at low speed.
2—Engine running at low speed under full power.
3—Engine running light at maximum speed (1000 r.p.m.).
4—Engine running at maximum speed under full power.

Case I.

In Case I, the loads acting on the crankshaft will necessarily be very small—in fact, negligible. We may, therefore, dismiss this case as of no consequence.

Case II.

In this case, on account of the low speed we may neglect the centrifugal and inertia forces. There are then left for consideration the pressures due to the gaseous mixture (expansion and compression strokes).

The mean pressure during the expansion stroke we will denote by P and the mean pressure during the compression stroke by p. The average pressure on any one crank pin during four consecutive strokes, *i. e.*, expansion, exhaust, suction and compression, is then

$$p' = \frac{P+O+O+p}{4} = \frac{P+p}{4}$$

From the diagram, Fig. 5, which is laid out for a particular engine to be specified further on, we obtain

$$P = 2380 \text{ lb. and } p = 272.5 \text{ lb.}$$

Hence for this specific case we obtain an average crank pin pressure of

$$p' = \frac{2380 + 272.5}{4} = 663 \text{ lb.}$$

The crank pin load is divided between the main bearings in definite proportions. Referring to Fig. 1, we note that these partial loads on main bearing I may be expressed as follows:

*From a paper read before the Buffalo Section of the S. A. E.

Longer Center Bearings

IN this article, Mr. Burkhardt, who is mathematical research engineer for the Pierce-Arrow Motor Car Co., shows that in a 3-bearing 4-cylinder engine, as commonly used on motor trucks, the load on the center bearing is very much greater than most designers realize, to judge by the dimensions they give to this bearing.

All the factors on which the load depends, viz., explosion and compression pressures, inertia forces of engine reciprocating parts and centrifugal forces on rotating parts, are taken into consideration, and the loads are determined for both low speed-full load and high speed-no load operating conditions.

Mr. Burkhardt finds that the center bearing should be considerably longer even than the rear end bearing, which, in addition to its other loads, has to carry the weight of the flywheel.

Load during expansion in cylinder I $= P \times \frac{a}{c}$ lb.
" " exhaust " " I $= O$ lb.
" " suction " " I $= O$ lb.
" " compression " I $= p \times \frac{a}{c}$ lb.
" " expansion " " II $= P \times \frac{c-a}{c}$ lb.
" " exhaust " " II $= O$ lb.
" " suction " " II $= O$ lb.
" " compression " II $= p \times \frac{c-a}{c}$ lb.

From this it follows that the average pressure on main bearing I during one complete cycle is

$$p' = \frac{P\frac{a}{c} + p\frac{a}{c} + P\frac{c-a}{c} + p\frac{c-a}{c}}{4} = \frac{P+p}{4}$$

Exactly the same loads as enumerated above are impressed on main bearing III in consequence of the forces acting in cylinders III and IV. All forces here under consideration act in the same direction. It is, therefore, evident that the average load on the central bearing is equal to the difference between the sum of the average loads on all four crank pins and the loads on the two end bearings. Hence, the average pressure on the central bearing during four strokes is

$$p'' = 4 \times \frac{P+p}{4} - 2 \times \frac{P+p}{4} = \frac{P+p}{2}$$

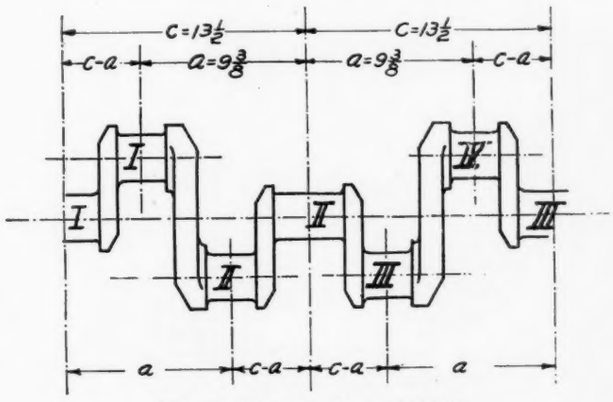


Fig. 1—Layout of crankshaft

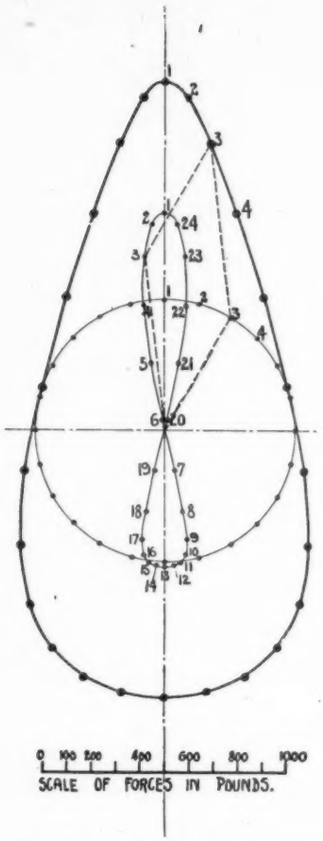


Fig. 2 — Crankpin pressure diagram for light load at high speed

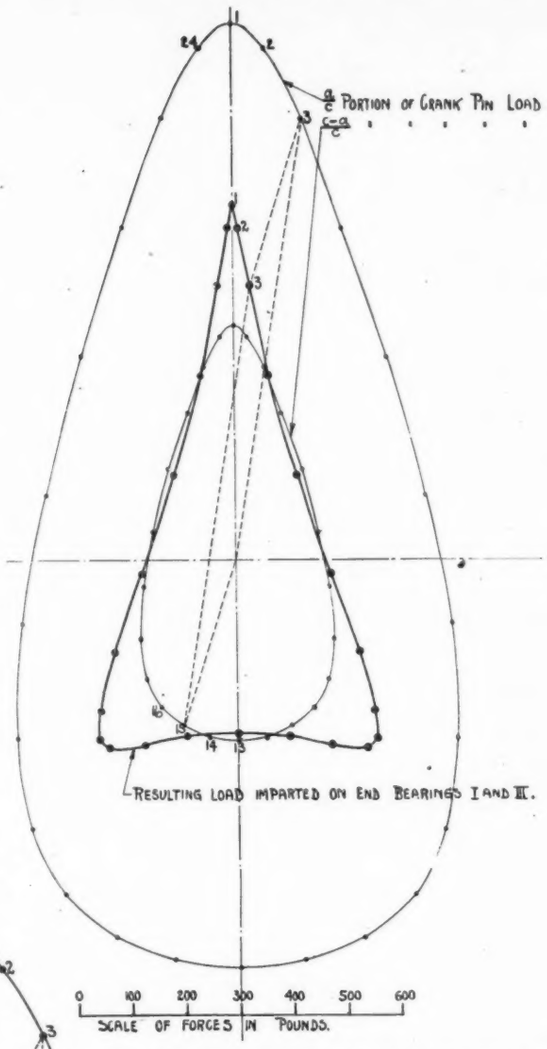


Fig. 3—Diagram showing distribution of crankpin loads between main bearings

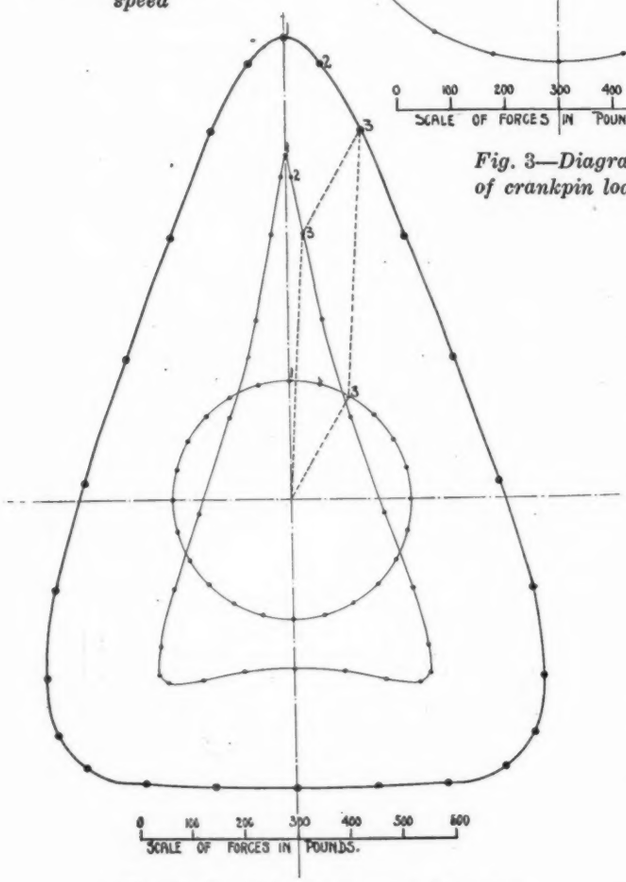


Fig. 4—Resulting loads on end bearings

In our particular example we obtain for the end bearings I and III an average pressure of

$$p' = \frac{280 + 272}{4} = 663 \text{ lb.}$$

and for the central bearing we obtain

$$p'' = \frac{2380 + 272}{2} = 1326 \text{ lb.}$$

Case III.

In this case, we may neglect the pressures due to the gaseous mixture. The only forces to be considered are those due to the inertia of the reciprocating parts and the centrifugal forces. Now, as the inertia forces are affected by the angularity of the connecting rod, and as the centrifugal force is continually changing in direction, no simple universally applicable formula can be evolved for magnitude and direction of the various mean pressures, as in the former case. We shall, therefore, confine ourselves to one particular example, that of a 4-cylinder engine of 4½-in. bore by 6¾-in. stroke. The total reciprocating weight, consisting of the piston with pin, rings, set screw and the small end of the connecting rod, is 7½ lb. The total rotating weight acting on one crankpin is 5½ lb. The inertia and centrifugal forces are all calculated for 1000 r.p.m. of the engine.

The inertia forces acting on the crankpin during one revolution are represented in magnitude and direction by the diagram, Fig. 2, which resembles a lemniscate. This diagram of forces includes certain horizontal component forces which have their origin in the angularity of the connecting rod. The concentric circle shown in the same figure represents the centrifugal forces (530 lb.) acting on the crankpin. If now the inertia forces are combined with the centrifugal forces as indicated by dotted lines for one crank position, we obtain a diagram of elliptical shape which represents magnitude and direction of the resulting loads on the crank pin.

From this latter diagram we find that the maximum load on the crank pin is 1415 lb., the minimum load is 530 lb. and the average load is 940 lb.

These crank pin loads are divided between the main bearings in a definite proportion, as already explained. The partial loads, in the proportions indicated in Fig. 1, are graphically represented in Fig. 3, where they are designated as fractions $\frac{a}{c}$ and $\frac{c-a}{c}$ of the total crank pin load. (Note that a larger scale has been chosen.)

To determine the load on the end bearings, we have to combine components 1, 2, 3 and so on to 24 of the $\frac{a}{c}$-diagram with simultaneously acting component forces of the $\frac{c-a}{c}$ diagram, *i.e.* with 13, 14, 15 and so on to 12. This yields the diagram of resulting forces which is marked "Resulting Loads on End Bearings I and III."

The same principle of combination must be followed in determining the loads on the central bearing. However, since the central bearing is affected by the loads on all of the four crank pins, it is evident that the resulting loads are all twice as large as those acting on the end bearings.

In the present case, we must, further, consider the centrifugal forces due to the crank pins and the adjacent crank cheeks. The crank pin and those portions of the adjacent crank cheeks which are not balanced in their own plane weigh, for the engine under consideration, about 6 lb. The centrifugal force due to this mass is 575 lb. at 1000 r.p.m. If we denote this centrifugal force by C we find by reference to Fig. 1 that each of the two main bearings I and III receives the partial load:

$$L_c = C\frac{a}{c} - C\frac{(c-a)}{c} = C\frac{(2a-c)}{c}$$

Substituting the dimensions given in Fig. 1, we obtain

$$L_c = 575 \times \frac{2 \times 9 - \frac{3}{8} - 13 - \frac{1}{2}}{13 - \frac{1}{2}} = 225 \text{ lb.}$$

Again the load on the central bearing is twice as large as the load on either end bearing, that is, 450 lb. We may now determine the total load on the end bearing which, by virtue of the existing symmetry, at the same time represents one-half of the total load acting on the central bearing.

In Fig. 4 the triangular thin line diagram represents the loads due to connecting rods I and II, III and IV, respectively, on the two end bearings, while the concentric circle represents the centrifugal force of 225 lb. If corresponding forces of these two diagrams are combined, taking account of their phase relation, as indicated by dotted lines, we obtain the resulting forces acting on the end bearings. The resulting diagram (heavy lines) shows a maximum load of 875 lb. and a minimum load of 385 lb., and by summation we obtain the average load of 600 lb. While these loads have been calculated for the two end bearings, we can find from them the loads on the central bearing by simply multiplying them by two. This gives a maximum load of 1750 lb., a minimum load of 730 lb. and an average load of 1200 lb.

Case IV.

In this case we have to deal with the forces due to the gaseous mixture as well as with centrifugal and inertia forces. While the writer does not underestimate the difficulty of determining exactly the forces acting during the expansion and compression strokes, a fair estimate of these forces may be made from the diagram Fig. 5. This diagram has been drawn to conform as nearly as possible to indicator diagrams obtained in practice. It represents a total of 1040 ft. lb. of work, which in the case of a 4-cylinder engine when running at 1000 r.p.m. would mean.

$$\frac{1400 \times 4 \times 500}{33000} = 63 \text{ indicated horsepower.}$$

If we allow about 14 per cent for engine friction, we obtain an effective output of 54 hp. This in turn corresponds to a mean effective pressure of 100 lb. per square inch of piston area. This may be somewhat higher than what is generally obtained with truck and tractor engines; it is, however, less than the rather desirable standard set by aircraft engines which we endeavor to approach.

With this mean effective pressure as a basis, the horsepower output at 1000 r.p.m. can be determined for any similar engine by means of the simple formula:

$$HP = \frac{b^2 s n}{10} \text{ where}$$

b = bore in in.
s = stroke in in.
n = number of cylinders.

The pressure due to the gaseous mixture throughout the stroke, as determined from Fig. 5, together with the inertia forces and certain horizontal components due to the angularity of the connecting rod, are graphically represented by the irregular thin line diagram of Fig. 6. Of course, during the expansion stroke there are gaseous forces of considerable magnitude, while during the next three strokes the inertia forces predominate. This accounts for the reappearance of the same force diagram which was shown in Fig. 2. The circle shown in Fig. 6 represents the centrifugal force acting on the crankpin. If now we combine corresponding forces as before, we obtain the total load on the crankpin as represented by the heavy line diagram.

From the latter we obtain the following characteristic loads:

Maximum = 4075 lb. Minimum = 530 lb. Average = 1230 lb.

These loads are divided between the main bearings in the proportion of $\frac{a}{c}$ to $\frac{c-a}{c}$ These partial loads are represented in Fig. 7. Now, to obtain from these the load on the end bearings we have to combine forces 1, 2, 3 and so on to 24 of the $\frac{a}{c}$ graph with forces 13, 14, 15 and so on to 1 of the $\frac{c-a}{c}$ graph. This yields the irregular thin line diagram shown in Fig. 8. If the resultant forces so obtained are now combined with the centrifugal forces shown in the same figures, we obtain the heavy line diagram which represents the resulting forces acting on the end bearings.

The characteristic loads obtained from this diagram are:

Maximum = 2945 lb. Minimum = 380 lb. Average = 1000 lb.

To obtain the loads on the central bearing due to crankpins 1 and 2, we have first to combine forces 1, 2, 3 and so on to 48 of the $\frac{c-a}{c}$ diagram with 13, 14, 15 and so on to 1 of the $\frac{a}{c}$ diagram. This yields the diagram shown in Fig. 9. This diagram also represents the forces on the central bearing due to crankpins 3 and 4. We must, however, bear in mind that the latter are in phase 360 degrees behind the former. If we, therefore, combine forces 1 to 24 of the diagram in

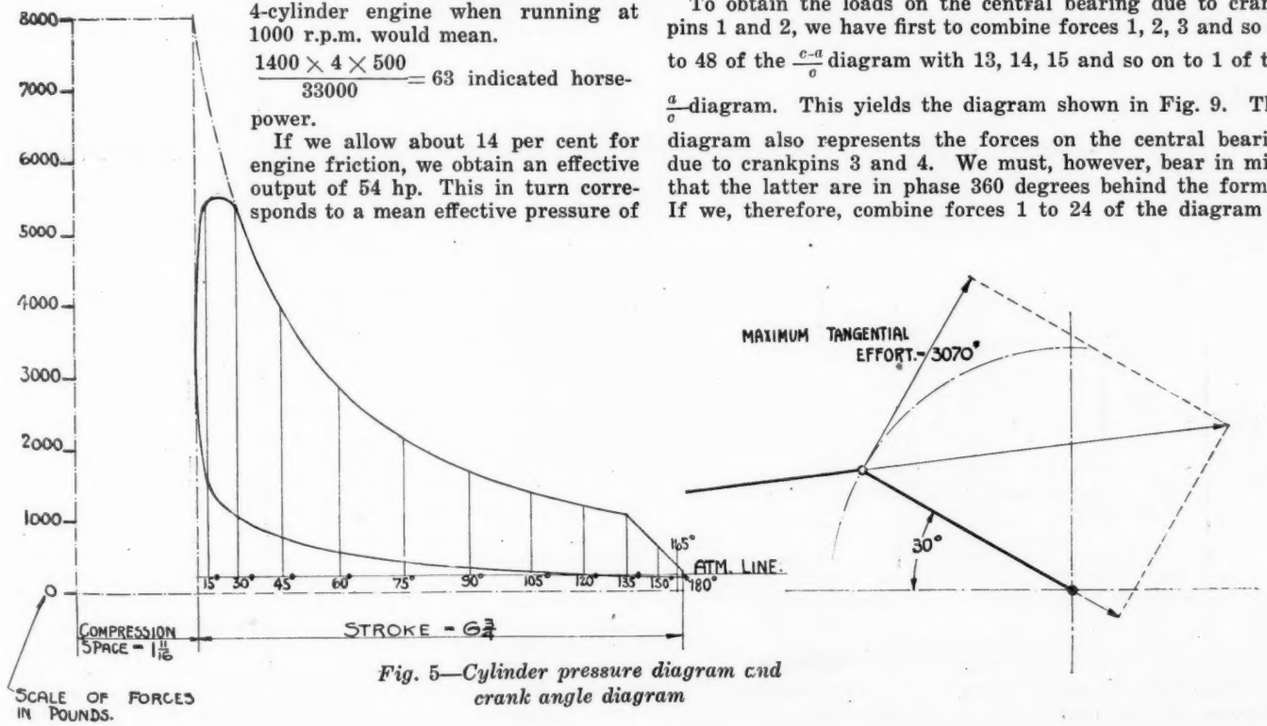


Fig. 5—Cylinder pressure diagram and crank angle diagram

Fig. 9 with forces 25 to 48 of the same diagram we obtain the irregular thin line diagram shown in Fig. 10.

If these forces are in turn combined with the centrifugal forces also shown in Fig. 10, a final diagram is obtained which represents the total load on the central bearing.

We obtain from this diagram the following characteristic bearing loads:

Maximum = 2690 lb. Minimum = 580 lb. Average = 1500 lb.

The same force diagram is obtained whether the firing order is 1-3-4-2 or 1-2-4-3.

The various bearing loads so far obtained are compiled in Table I, in which are also given certain figures representing the proportional lengths required for the different bearings. The crankpin length has been taken as unity. These relative figures presuppose that the crankpins and the main bearings are of equal diameter, which is considered good practice for three-bearing shafts.

TABLE I.

Running condition of engine	Condition of load	Crank-pin	End bearings	Center bearings
Low speed	Maximum	5200	3600	3600
Full power	Average	663	663	1326
	Relative bearing length	1	1	2
High speed	Maximum	1415	875	1750
Zero power	Average	940	600	1200
	Relative bearing length	1	.64	1.28
High speed	Maximum	4075	2945	2690
Full power	Average	1230	1000	1700
	Relative bearing length	1	.812	1.38

From the first group of forces pertaining to low engine speed and full horsepower output, we note that the effective lengths of the crankpins, the end bearings and the central bearing should be in the proportion of 1 to 1 to 2 respectively. From the second group of forces we note that for high engine speed and zero power output the effective bearing lengths should be made in the proportion of 1 to 0.64 to 1.28. Finally, for high speed and maximum power output the bearing lengths should be made in the proportion of 1 to 0.812 to 1.38.

To make the best use of these figures we must compromise. For instance, the engine here under consideration will run at high speed (near 1000 r.p.m.) about 80 per cent of its life, under which condition it develops power varying from zero to the maximum output. The limiting conditions are Case III and IV. The bearing lengths required to conform to this running condition are the mean of the lengths determined for the limiting cases, hence,

$$\text{Relative end bearing length} = \frac{0.64 + 0.812}{2} = 0.726;$$

$$\text{Relative center bearing length} = \frac{1.28 + 1.38}{2} = 1.33.$$

We are at present concerned with the problem of minimizing the unavoidable wear and preventing uneven wear which causes unnecessary stresses in the structural parts. This requires that adequate attention also be given to the remaining 20 per cent of the engine's life, during which it is running at low speed developing full power, as investigated under Case II (acceleration and hill climbing).

This consideration leads to the following final proportions:

Relative crankpin length = 1.

Relative end bearing length = 80 per cent of 0.726 + 20 per cent of 1 = 0.78.

Relaitve central bearing length = 80 per cent of 1.33 + 20 per cent of 2 = 1.46.

Let us choose for our example an effective crankpin length of 2½ in. We then obtain end bearings of

$$0.78 \times 2\tfrac{1}{2} = 1\ 15/16 \text{ in. length}$$

and a central bearing of

$$1.46 \times 2\tfrac{1}{2} = 3\tfrac{5}{8} \text{ in. length.}$$

The front end bearing should be lengthened about 5/16 in. to allow for the load due to the timing gears, whereas at least 1 in. effective length should be added to the rear end bearings to compensate for the effect of the clutch and the flywheel. Allowing further ⅛ in. for each fillet we obtain the following compilation:

TABLE II.

Bearing	Nominal length	Allowance for fillets	Other allowances	Actual length
Crankpin	2½	2 × ⅛ = ¼		2¾
Front end	1 15/16	⅛	5/16	2⅜
Rear end	1 15/16	⅛	1 1/16	3⅛
Central	3⅝	2 × ⅛ = ¼		3⅞

Some consideration may now be given to the diameters

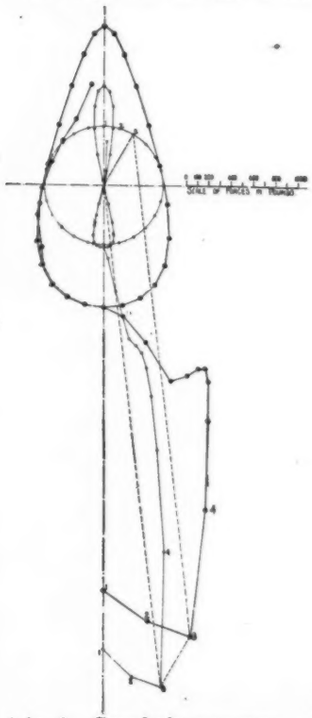


Fig. 6—Crankpin pressure diagram for full load

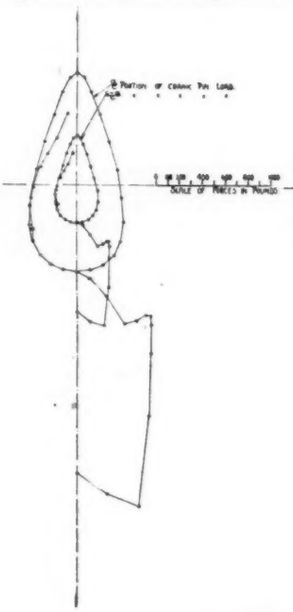


Fig. 7—Each end bearing's share of the crankpin pressures

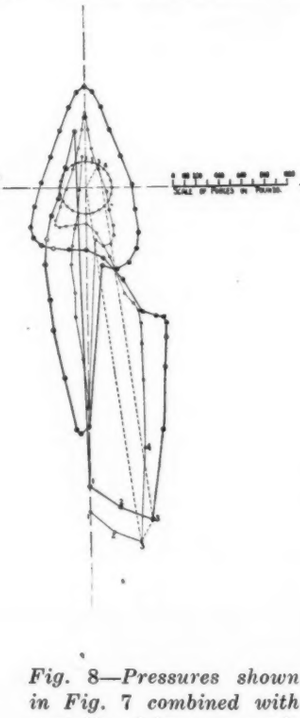


Fig. 8—Pressures shown in Fig. 7 combined with centrifugal force on crankshaft

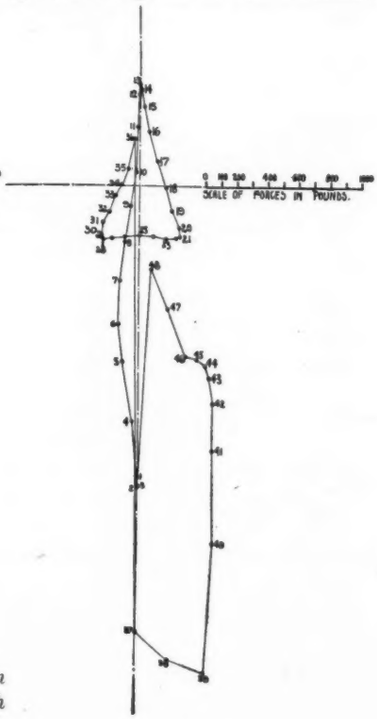


Fig. 9

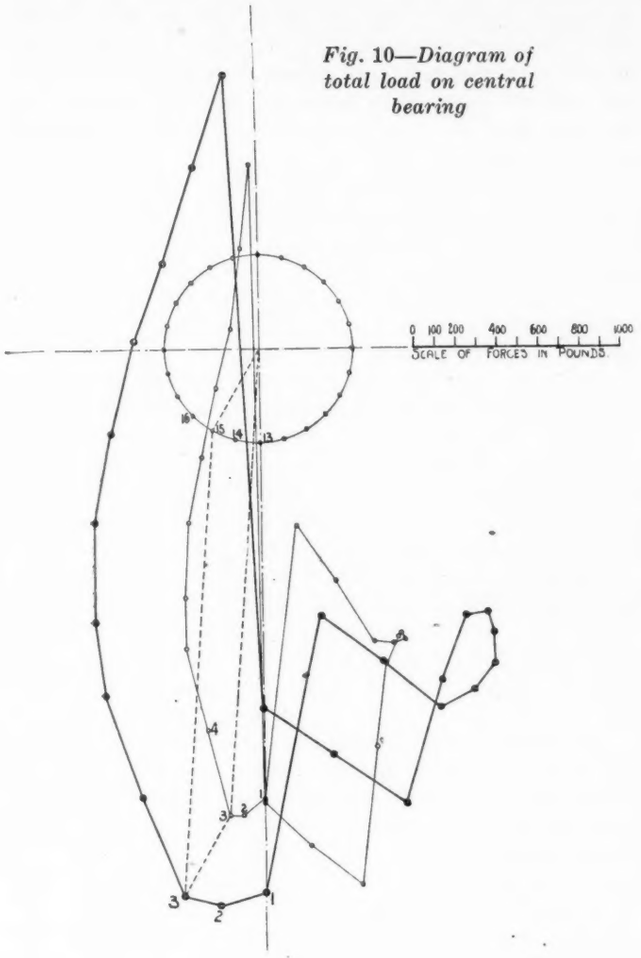


Fig. 10—Diagram of total load on central bearing

of the crankpins and the journal bearings. In Fig. 5 it is shown that the maximum tangential effort is 3070 lb. This force when exerted on crankpin I or III can be resisted only through forces set up in crankpins II and IV respectively. The lever arm on which the force cf 3070 lb. acts is the distance between the centers of the crankpins. Consequently, crankpins II and IV are subject to a twisting moment of

$$3070 \times 6\tfrac{3}{4} = 20700 \text{ lb.-in.}$$

The elastic limit of the crankshaft material may be taken as 80,000 lb. per square inch. The factor of safety desired is 10. Denoting by d the diameter of the crankpin, we have the following equation:

$$20700 = \frac{J}{16} \times d^3 \times \frac{80{,}000}{10}$$

Hence

$$d^3 = 13.18 \text{ or } = d = 2.36, \text{ say } 2\tfrac{3}{8}.$$

Let us now compare our results with others advanced by a highly esteemed authority. This authority states: "The average lengths for the three main bearings, taking the length of the connecting rod big end bearing as 1, are 1.21 for the front, 1.17 for the middle and 1.48 for the rear." These results deviate considerably from those arrived at above, which is due to the fact that they were obtained by measuring up the bearings of a number of engines. Now, it is a fact that of these engines only one or at most a few had their bearings even nearly properly proportioned, and the influence of the great amount of data from engines with improperly proportioned bearings spoiled the results.

Another rule of thumb is to the effect that the crankpin diameter should be $0.4 \times b + \frac{1}{4}$ in. With this formula we would obtain for our engine a diameter of 2.05 in. By substituting this in our equation for d we find the factor of safety from the equation—

$$20700 = \frac{J}{16} \times 2.05^3 \ \frac{80000}{F}$$

or

$$F = 6.5.$$

This is obviously too small for so important a part as the crankshaft.

Liberty Carbureter Air Intake

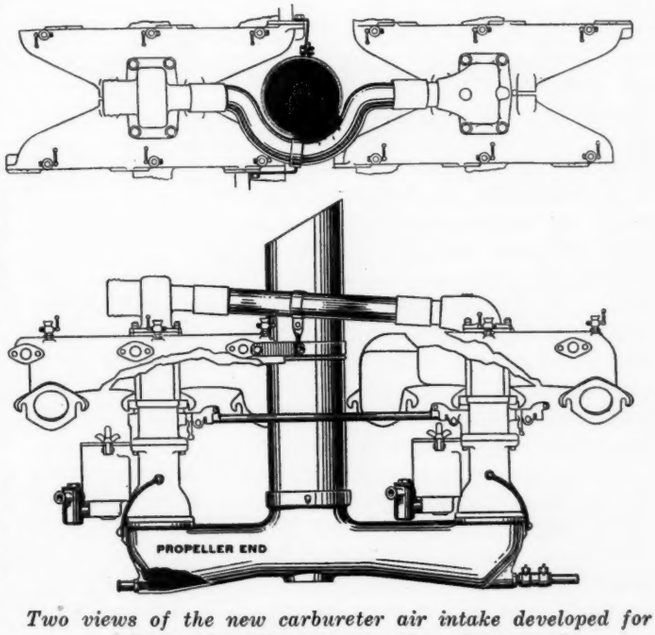
TOWARD the closing days of the war a number of tests were conducted at Detroit and McCook Field, Dayton, to determine the best way of modifying the carbureter air intake on the Liberty engine to decrease the fire hazard. The accompanying illustration shows the design which was found to be the most satisfactory for this purpose. It consists of a T-shaped casting, with the air intake extending upwards, in the form of a pipe stack, through the top of the engine bonnet. Drain tubes are provided at either end to carry the gasoline waste outside of the fuselage.

Dynamometer and flight tests made at McCook Field demonstrated the new arrangement to be fully as efficient, as regards its effect on engine output, as that of the old, while the fire hazard has been greatly reduced, as all gasoline drippings are conducted away from the hot engine V, and the carbureter back-fire flame is carried out of the hood. This thorough gasoline drainage and consequent absence of combustible vapor also protects the pilot against the fire hazard due to incendiary bullets passing through the bonnet.

With this construction it is not difficult to make an inspection or a change of jets. By sliding up the pipe stack, springing off the attaching bails and disconnecting the drain tubes, the manifold can be moved forward or backward, as desired, to reach the jets of either carbureter.

The changes necessary in making this installation consist of replacements to provide clearances for the new intake stack and its parts. These changes consist of a new offset or curved intake header water outlet extension, and a new offset or curved carbureter throttle control connection. New and larger drain tubes are also included.

A hole had to be cut in the engine bonnet to provide for the exit of the air intake pipe stack, which is cut at an angle above the top of the bonnet, so that pressure may be produced in the air intake by the propeller slip stream.



Two views of the new carbureter air intake developed for Liberty aircraft engine to reduce fire hazard

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Crankcase Breathers on Tractor Engines

DUST is the bane of tractor engines and tractor mechanism in general. It gets into the cylinders, the crankcase and gear case, and works havoc with bearings and joints. Much attention has been paid to the problem of keeping it out of the cylinders. The carbureter air inlet is provided either with a sort of periscope which draws the air from above the normal height of the dust cloud, or, more frequently, with an air cleaner or an air washer designed to abstract all of the dust from the air before it enters the engines.

There is, however, another breathing organism in the engine, namely, the crankcase. A few engines are operated with absolutely closed crankcases and, therefore, cannot accumulate any dust in their oil pans. Unfortunately this system is impossible where splash lubrication is used, as the oil would be forced out through the bearings and through joints in the crankcase walls. The oil, of course, is also forced out with other systems of lubrication by the excess pressure in the case, but when it is not intended to use the oil over, this does not matter, except for the fact that the machines will probably be mussed up considerably.

Closing the crankcase absolutely can hardly be considered a general solution of the difficulties referred to in the foregoing. In a two cylinder opposed engine, for instance, there is a very strong fluctuation of pressure with the simultaneous inward and outward movement of the two pistons respectively, and in a four cylinder engine there is a moderate fluctuation in pressure due to the unequal velocities of the upward and downward moving pistons.

There are, generally speaking, two types of breathers. In one design the flow of air both into and out of the crankcase is practicaly unobstructed, but there are a series of inclined, staggered partition walls extending part way across the passage. The oil particles, striking these walls, adhere to them, and when a sufficient quantity collects it flows to the lower edge of the wall and is carried back into the crankcase by the inflowing current of air. This type of breather is used on almost all automobile and a majority of tractor engines.

The other type of breather contains a valve, either positively or pressure-operated. If the valve is pressure-operated it will open only when the crankcase pressure exceeds the atmosphere pressure, when a slight amount of air will be forced from the case. As soon as the pressure within the case falls to atmospheric the valve closes, and during the greater part of the time the pressure within the crankcase is below atmospheric; that is, there is a partial vacuum in the case. If the valve is operated mechanically it is timed to open and close at about the same periods as the pressure-operated valve, and a breather of this type would seem to be much better suited to a tractor engine than the common design with oil separating partitions. It gives substantially the advantages of a closed crankcase without the tendency of forcing the oil out through the bearings. If in addition the breather were provided with a standpipe extending beyond the usual height of the dust cloud it should be quite possible to keep the crankcases of tractor engines tolerably free from dust and grit.

"Ready for the Road"

PREVIOUS to the war practically all of the so-called automobile constructors of France sold to their customers not complete automobiles but chassis without body, without tires and without such articles of essential equipment as lights, horn, tire pump, etc. One reason advanced in justification of this practice was that the French public has an artistic temperament and loves individuality. They do not want machines built to a pattern, like coffee grinders, but prefer to have their bodies built to order and to purchase for their cars those articles of equipment which appeal to them the most. The wastefulness of building bodies to individual designs

had never been strongly impressed on the French purchaser, and up to the outbreak of the war the plan seemed to work satisfactorily.

One of the radical changes which the war has brought about in the French industry is that in future all automobiles will be sold as complete machines ready for the road. Not only the chassis, but the body as well, will be a quantity production job. Even before the war the competition of certain low-priced American cars had somewhat disturbed the French makers, but they consoled themselves with the thought that Frenchmen would not buy a machine with a body that did not please their artistic sense. During the war these makers had plenty of opportunity to observe the behavior of these low-priced vehicles in service. Their experience evidently was such as to lead them to the conclusion that it would be impossible in future to sell to the customer a French chassis at about the same price that he can buy an American car with complete equipment for. The cost of the French chassis often was only about 50 per cent of the total outlay for a car. Something had to be done to reduce the cost of the complete machine, and the item which offered the greatest opportunity for economy was the body. The body formerly fitted to French chassis was a hand-made product, often made from individual designs. When the bodies are made in large quantities, of standard designs, greatly improved manufacturing processes can be introduced, and the cost can be materially cut. Therefore, the French makers almost without exception have decided in the future to sell complete cars with standard designs of bodies.

As regards accessories, the situation has a somewhat different aspect. It is impossible to say whether production methods will be much affected by the change in selling plan. However, the offer of a machine completely equipped to take the road cannot fail to appeal to the purchaser. Moreover, if the manufacturers of such accessories as lamps, pumps, jacks and horns sell to the car manufacturer instead of to the ultimate consumer they can materially reduce their selling cost, and thus a future economy be effected.

The Motorized Farm

IT is evident that before long a somewhat broader view will have to be taken of the substitution of mechanical power for animal power on the farm. The farmer cannot dispense with his horses unless he can buy equipment that will do all of the work which he is now doing with horses. The conventional farm tractor is designed principally for plowing; it serves tolerably well for such other farm operations as disking, harrowing, grass cutting, hay loading, etc., and for belt work.

But there is other work on the farm, ordinarily done by horses, to which the tractor is ill suited. This includes cultivating, corn harvesting and general haulage work. With the ordinary type of clearance tractor it is absolutely impracticable to do cultivating; and even if the tractor is built with sufficient clearance, the use of, say, a 3-plow tractor to pull a 2-plow cultivator would be very uneconomical. Cultivating must be provided for, and the line of the future power farming equipment manufacturer therefore will include a cultivator.

Another line of farm work to which the tractor does not lend itself is corn harvesting. In husking corn use is generally made of a two-horse wagon. The horses will follow the rows of their own account and do not need to be guided, hence the men accompanying each wagon can devote all their time to husking. If the horse is to be displaced in corn harvesting, some mechanical method of husking must be at the same time adopted. Pullers are already in use which pull the ear with the husk off the stalk and transfer it by means of a belt conveyor to the wagon. No doubt, such a puller could be attached to a motor truck.

For all the general haulage work on the farm a motor truck is the best vehicle if the roads in the neighborhood are good.

Motor trucks have already been sold to farmers in considerable numbers, and the statement has been made that the sale of every farm tractor opens the way to the sale of a truck. It is quite possible that the ordinary motor truck, designed with a view to its use in the city, is not best adapted for farm service. Several makers are now looking into the farm truck problem, and there is a possibility that as a result a special farm truck will be developed.

Radiator Fans

UNTIL recently it has been the custom for engine manufacturers who sell their product to passenger car or truck makers to furnish a radiator fan with it, but this practice is now being abandoned. This is merely a further step in the movement to make fan manufacture an independent branch of the automotive industry. Originally most engine builders, whether they were specialists or manufacturers of complete cars, produced their own fans. The fan looked like such a simple proposition that it seemed a shame to buy it and pay some one else a profit on it. But it was soon discovered that the problem of fan design and manufacture was not such a simple one after all. There are frequent cases of inadequate cooling due to improper fan design, and trouble with fan bearings has been common.

As fan manufacture becomes specialized, the various problems involved in the design of this fitting will receive closer attention. Competition between the different makers in this particular field will be a strong factor compelling refinement of details. By consulting with the experts of a fan manufacturing concern the car manufacturer will be able to make a more intelligent choice of fan diameter, blade width and fan speed. The problem of durable bearings and of efficient, non-slipping drives is being investigated by the fan makers, and there is no doubt that before long, as a result of the specialization in manufacture, the radiator fan will have reached a degree of perfection commensurate with that of other engine fittings.

Latest News of the

Parts Shortage Ties Up Production

Makers Waiting for Steel Prices to Drop—Car Sales Ahead of Manufacture

DETROIT, March 18 — Automobile production in the Detroit district will not reach normal until the iron and steel market is stabilized. The big companies themselves are not affected so much as are the parts makers who are withholding their steel and iron purchasing for a price reduction which all seem to be expecting. As a result there is a curtailment of parts production which is reacting on the car makers who need all parts material available to meet their production demands.

Price reductions in the various steel lines are regarded as assured by the rank and file of consumers, and they are holding back orders except where guarantee against decline is given. The steel market has been sluggish for some weeks and this air of expectancy is slowing it up more than ever.

Big Demand for Cars

Another big element in sub-normal production is the failure to settle war contracts. Here again it is the parts maker who is hit the hardest. He has not been able to collect from the companies who cannot collect from the Government, and as a result a big portion of his working capital is tied up.

Most of the companies have switched from war to peace conditions and are all ready for normal production work. There is a demand for more cars than the companies are able to produce. Nearly every automobile company sales department is from 30 to 90 days ahead of production. This brilliant business future has offset to a large degree timidity of the manufacturer caused by the government tie-up of his working capital, and most of them have secured more money and are going ahead.

As already seen, production in February was nearly double that of the preceding month, and March statistics, already issued by some firms, are going to show an increase in almost every instance of from 10 to 40 per cent. Besides the number of new accessory companies who have placed or are about to place new devices upon the market, the next few weeks will see several new car, truck and tractor concerns start in business.

Labor conditions in Detroit and Michigan are almost normal. There is a small surplus of unskilled labor, but this is being rapidly absorbed by the companies. In skilled lines, mechanics, machinists, etc., the surplus is changing to a shortage. Many companies find it necessary now to advertise for such men, which is something they have not done since December.

Statistics compiled by the various banking interests of the city, who made an exhaustive investigation of business conditions, show that on March 1 approximately 50 per cent of the business in the city was below normal. This is a slight increase over the preceding month. On the same date 30.01 per cent of the companies reported normal business, while 19.99 per cent declared conditions were above normal.

The Chamber of Commerce declares there is a great shortage of factory buildings in Detroit, and consequently has launched a campaign which it hopes will result in the erection of many new structures. Two score firms are unable to begin operations until their needs for floor space are met.

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Saxon Financial Reorganization Plans

DETROIT, March 15—A special meeting of the stockholders of the Saxon Motor Car Corp. will be called soon to allow them to vote on a plan for clearing up the company's indebtedness, either through an assessment or through a reorganization. Plans for the financing of this company have been completed by a creditors' committee composed of Detroit and Chicago bankers.

Under one plan to be submitted the stockholders will be asked to vote on an assessment against them for the full amount of the indebtedness of the company. Under the second plan a complete reorganization will be asked which would virtually wipe out the $6,000,000 stock of the company.

It is proposed under the second plan to issue $2,000,000 in bonds, $1,250,000 preferred stock and $3,200,000 in common stock. The creditors feel confident of the future of the company under the plan and are willing to take common stock in return for their obligations at par, provided they are given option on the remaining common stock.

Claims against the company total $2,400,000. The creditors therefore will obtain an option on $800,000 common stock. The bonds and preferred stock would be purchased by a banking syndicate and offered for public sale.

The Saxon Co. erected a plant on Ford Road and Western Avenue, north of Michigan Avenue. The plant was never occupied by the company and is under lease to the government. It will be utilized, however, when the new financing is completed.

Harvester Adopts Council Plan

All But Three Works Vote in Favor—17,558 Vote for It, 10,150 Against

CHICAGO, March 17—On Monday, March 10, the International Harvester Co. submitted to its seventeen American and three Canadian works the "Harvester Industrial Council" plan of employee representation which was printed in full in AUTOMOTIVE INDUSTRIES last week. Elections were held on Wednesday, March 12, by the employees at all plants to decide by majority vote whether or not it should be adopted.

The vote by plants is fully set forth in the table herewith. It shows that all but three of the works decided in favor of the plan, these three being the McCormick works, the McCormick twine mill and the tractor works, situated on Chicago's west side. Bulletins were posted at all works announcing the result.

At the works which rejected the plan the notices stated that no further action would be taken in the matter there except upon request of the employees. Soon after the results of the election were made known, the employees at these three plants began circulating petitions asking that the plan be re-submitted.

At the plants where the plan has been adopted preparations began at once to organize the Works Councils, which are the outstanding and fundamental feature of the plan.

The total vote—28,611, including 903 spoiled ballots—was one of the surprises of the election. There were present on election day 29,125 eligible employees and no effort was made to stimulate voting or to urge adoption; all employees were perfectly free to vote for or against the plan, or to refrain from voting. The total vote thus evidences a much deeper initial interest in the plan among employees than has been developed in other industrial establishments in similar circumstances.

The plan is a progressive development of the company's industrial policy which has heretofore led to the inauguration of the weekly pay system and the basic 8-hour day, and still earlier to voluntary adoption of a workman's accident compensation plan antedating American legislation on that subject, as well as the Harvester Pension plan, wholly supported by the company, under which 523 employees have been retired on pension; also the Employees' Benefit Association, which has paid out in 10 years more than $3,000,000 to employees and their families.

The cornerstone of the plan is the Works Council, charged with the duty of considering and making recommendations to the management as to working conditions, health, safety, hours of labor, wages, recreation, education and other similar matters of mutual interest.

Equality of voting power between the representatives freely elected by the employees and those appointed by the management; the unit rule of voting in the Council; the right of all employees to present suggestions, requests or complaints; the assured independ-

(*Continued on page* 663)

Automotive Industries

British Import Rule Still Undecided

Neither Detroit Manufacturers Nor Canadian Authorities Have Official Word

NEW YORK, March 20—No authoritative word has been received as yet from England regarding the removal of import restrictions on British-made products from British colonies. Early last week it was reported that Great Britain had let down the import bars to the extent that products produced in British colonies would be permitted entry into England. Detroit manufacturers are still expectantly awaiting authentic information, in view of the importance of the matter to those of them who maintain Canadian plants.

Customs authorities in Windsor, Canada, across the river from Detroit, have not yet received official word from their government, and until they receive such information the whole matter will remain in a chaotic condition. Windsor officials have communicated with government authorities in Ottawa and almost momentarily expect word.

Dispatches purporting to come from official sources have let it be known that such Canadian plants are as merely assembly plants and are not in reality Canadian factories, producing their merchandise complete, will not benefit; it is intimated that only products manufactured complete in British colonies will be permitted entry under the ruling.

The War Trade Board in Washington has just issued a ruling, under the terms of which all import restrictions covering raw materials of all character are rescinded, and such products will now be permitted to enter Great Britain freely.

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Partial Foreign Trade Convention Program

NEW YORK, March 20—The Sixth National Foreign Trade Convention, which is to be held next month in Chicago, will be devoted to a considerable extent to questions involving export matters and export shipping. Eugene Meyer, Jr., managing director of the War Finance Corps, will talk on "Financing Our Excess of Exports"; William S. Culbertson of the U. S. Tariff Commission will cover the "Bargaining Tariff." In a session on the American Merchant Marine, Homer L. Ferguson, president of of the Newport News Shipbuilding & Drydock Co., will present a paper on "Shipbuilding," and this will be followed by one on "The Future of the American Merchant Marine on the Pacific," by Frederick J. Koster, president of the Associated Chambers of Commerce of the Pacific Coast. James A. Farrell, president of the U. S. Steel Corp., will discuss "An American Maritime Policy." The program of the meeting is in an embryo state as yet.

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Publicity for Trailer Makers

DETROIT, March 20—The Trailer Manufacturers' Association of America, which met here March 18, shortly will inaugurate an aggressive publicity campaign to bring the advantages of trailer transportation more prominently before industry. Twenty manufacturers were represented at the meeting and all have subscribed to a publicity fund. Harry W. Perry, up to the present with the National Automobile Chamber of Commerce, has been elected secretary of the association and its manager. General offices will be opened in New York City as soon as suitable quarters can be obtained.

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Parke Heads Olympian Motors

DETROIT, March 20—Fred K. Parke was elected president of the Olympian Motors Co., Pontiac, at its annual meeting, and it was voted to increase the capital stock to allow of needed expansion. Other officers elected were: Vice-president, St. Clair Couzens; secretary, C. E. Callender; treasurer, William Passmore.

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N. I. & V. A. to Hold Convention in Chicago

CHICAGO, March 19—The twenty-sixth annual convention of the National Implement and Vehicle Association will again be held here in October, according to the decision of the executive committee. This city is considered the most advantageous place for the meeting, as the general offices of the association are here.

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Speeding Up Canadian Production

DETROIT, March 18—Canadian production of Maxwell cars has reached 300 passenger cars and 50 trucks monthly. The Chalmers Co. of Canada is turning out 60 passenger cars monthly and is preparing to run up production as soon as the material situation makes it easier to obtain steel and automotive parts.

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Wilson Army Trucks for Post Office

DETROIT, March 18—The J. C. Wilson Co., makers of the Wilson trucks, has just concluded its contract with the Government and is now on a peace-time basis. The last trucks for the Government were shipped direct to the postmaster at York, Pa., and Columbus, O.

Tax Tangle Before Government

N.A.C.C. and M.A.M.A. Daily Expecting Rulings and Official Interpretations

NEW YORK, March 20—Definite rulings and interpretations of the new War Revenue Bill insofar as it applies to automotive products are still being awaited by the industry. Following conferences last week between representatives of the National Automobile Chamber of Commerce and the Internal Revenue Bureau, the Motor and Accessory Manufacturers' Association has taken up the matter through similar channels.

Last week the M. A. M. A. representatives presented their case before the Internal Revenue Bureau and this bureau now has before it the subjects which the M. A. M. A. wants definitely covered. Particular difficulty has arisen over the definition of the term "parts and accessories," and this is one of the matters which it is hoped may be cleared up. At present the matter is before the law division of the Internal Revenue Bureau and it is expected that definite rulings and interpretations may be received before the end of the week.

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Sherman Heads Air Training

WASHINGTON, March 20—Lieutenant-Colonel William C. Sherman has been detailed from the Engineers Corps as chief of the air service training. This will include heavier-than-air training at both the ground schools and training fields under Brigadier-General William Mitchell, last week appointed director of military aeronautics. Colonel Sherman will carry on the work for which Professor Herman Bingham of Yale University was brought into the service at the outbreak of war. Professor Bingham organized the various ground schools.

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Factories Increase Working Forces

LANSING, March 17—Since the first of the year factories here have added a very noticeable per cent to their production force. The largest increase noted is in the Auto Body plant, which was very short on war contracts. The first of the year this plant was employing 200 men. The first week of March over 700 were on the pay-roll. Its officials declare 1000 men will be needed soon to keep production up to schedule.

The Prudden Wheel Co. is now giving employment to 1000 men, a big increase since the first of the year. The number of men now employed equals the number

employed by this company before the war.

The Olds Motor Works readjusted quickly from war-work, and is now in the automobile and truck game full blast. The company has taken on many more men and its daily production of cars is about 125. The company is increasing its force daily.

The Reo Motor Car Co. added 200 men to its force in February. The pay-roll now shows 4000 men. Many more will be needed in March to care for the proposed production increases.

There is a big demand here for unskilled labor. Local industries, although held up by readjustment plans and anticipation of settlement with the government, are absorbing labor freely, and employment officials declare there are very few unemployed.

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Aeronautic Committee Sails for Europe

WASHINGTON, March 18—A Congressional committee to study aeronautics in Europe has sailed with Secretary Daniels. The committee comprises W. R. Green, Iowa; A. T. Smith, Idaho; W. A. Ashbrook, Ohio; John E. Raker, Cal.; C. W. Ramseyer, Iowa; B. L. French, Idaho, and H. W. Sumner, Texas.

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Daniels to Undertake Aircraft Development

WASHINGTON, March 17—Secretary Daniels, who sailed from New York late last week, announced that while abroad he will investigate aircraft development, and on his return to the United States, about May 1, he will begin preparation of an outline of experimental work in aircraft for submission to Congress, with the request for an appropriation to carry it out.

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Oldfield Suspension Reconsidered

NEW YORK, March 20—At a meeting of the Contest Board of the A. A. A. yesterday, the board reconsidered the question of suspending Barney Oldfield for unsanctioned driving, and in lieu of permanent suspension substituted a fine of $1,000.

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Hupp Increasing Production

DETROIT, March 18 — High steel prices are curtailing the operation of parts makers, but despite difficulty in securing parts and other materials, the Hupp Motor Car Co. is now running 65 cars daily, which is an increase of 10 cars a day over February production.

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Haskelite Co. Is Increasing Force

GRAND RAPIDS, MICH., March 18—The Haskelite Mfg. Co. is getting into peace production and is now employing 50 people. The factory has been employed to capacity on war work. The contract cancellation brought a suspension of operations, but production has been resumed and is increasing daily. The company is making pressed veneer automobile tops. As soon as the Grand Rapids plant nears capacity production the Ludington branch will be started again.

Outlook Excellent in New England

Boston Show Draws Bigger Crowd Than Last Year and Everyone Is Prosperous

BOSTON, March 18—Good business in cars, trucks and automotive equipment in New England is assured for the coming season if the show is any standard by which to judge. The attendance is larger than a year ago and the public interest is keen.

New England has made a lot of money this year. Her farms and forests have been productive and Central New England has been very busy with munitions and other work. Many of the emergency factories erected will be continued with peacetime products and there is every indication that the prosperity will continue.

Distributers say that dealers out through the territory are already getting good business and that the retail trade in Boston began to come back about the first of the year. January and February were pretty good months.

The show, as usual, is held in Mechanics' Building, and it is decorated in its typical Boston way. This year it is a victory show. Statues of victory and flags of the Allies are worked in profusion.

In previous years the truck show has always been a feature of the Boston exhibition and were space available Boston could put on this year one of the best truck shows that has ever been held. The truck show used to be held in the basement, but this year this space is taken up for the storage of government goods, and there are no trucks at all in the show.

In place of this a large bulletin board has been erected at the entrance, carrying the names and addresses of all the Boston truck dealers. The dealers are doing considerable newspaper advertising and endeavoring to hook up their business with the passenger car show.

The truck dealers say that their business has not been as active during recent weeks as it will be in from 30 to 90 days. All of them state that they see a big future ahead for truck selling in New England and they expect this market to open up actively in a very short time.

There are no tractors in the show, because there is no room, but the dealers are interested in this subject and are investigating it. One of the things they are investigating is what type of tractor will best operate on hilly New England farms.

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Durant Wins Santa Monica

SANTA MONICA, March 15—Cliff Durant, driving a Chevrolet, won the Santa Monica Road Race here to-day from fourteen starters. His time for the 250.24 miles was 3 hrs., 4 min., 45 sec., which is at the rate of 81.6 m.p.h. Hearne (Chevrolet) was second in 3:11:59, and Lecocq (Newman) was third in 3:15:8. Only three other drivers in addition to these finished the race. Pullen (Hudson) was fourth in 3:20:40.

Durant and Hearne started in first and second places and remained there throughout the race. Hearne completed the distance without a stop, but Durant was forced to stop twice for tires, losing about 1 min. in all. Al Melcher (Duesenberg) died as a result of an accident in which his car was overturned in the early stages of the race.

Prior to the start Ralph De Palma drove an exhibition circuit of the 7.396-mile course in 4:45 1/5, which is at the rate of 93.38 m.p.h. He drove the same Packard car with which he recently established records of from one kilometer to 20 miles on the Daytona Beach. His car was barred from the race because it had no place for a mechanic.

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Motor Trucks for Health and Post Office Departments

WASHINGTON, March 18—An allotment of 1500 motor trucks has been arranged for by the War Department for the Post Office Department, in addition to the 1200 which were recently transferred, as announced in a previous issue. These trucks are being used for rural mail truck routes. Few have as yet been actually operated, but plans are being perfected and it is expected that the 2700, and additional trucks, will be used soon. Arrangements have also been made to supply 1000 commercial type trucks to the U. S. Health Department, which will use these in various cities for the transfer of supplies.

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Campaign to Avoid Double License

DAVENPORT, IA., March 17—The question of getting uniform application of motor vehicle laws in Iowa and Illinois to eliminate the necessity for double licensing of commercial vehicles plying between the two states has resulted in the inauguration of a campaign by the various Tri-Cities civic bodies. The controversy has been on for several months. The interpretation of the present laws by both the Rock Island and Davenport authorities has been that a motor vehicle owned by a firm in one state, doing business or making deliveries in another state, must be licensed in both states. Backing the campaign are the Rotary Clubs of the Tri-Cities, the Greater Davenport Committee, the Davenport Advertising Club, the Retail Merchants Bureau of Davenport and the Chamber of Commerce and Retail Merchants Assn. of Rock Island.

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Wolverine Back in Production

KALAMAZOO, March 18—The Wolverine Motor Car Co., whose plant has been idle since 1917, has been reorganized and has just resumed operation. The new company proposes to manufacture 600 passenger cars this year, and the first machines are now in the process of production. The Wolverine cars will be

made in three models, the roadster to sell for $3,500, and four and six-passenger touring cars to sell at $3,750. A four-cylinder Duesenberg engine is used in all models.

The company is making its own bodies, fenders, gas tanks and a large number of smaller parts. Only one or two departments of the present plant are now in operation, but the rest will be started as soon as production increases. The company proposes to put up a new factory building this year.

The officers of the reorganized company are: President, A. H. Collins; vice-president and chief engineer, Harry A. Scott; secretary, W. H. Scott; treasurer, G. M. Bush. The board of directors is composed of the officers and J. W. Rider, Charles A. Blaney and J. P. Upjohn.

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Kerosene Prices Go Up

NEW YORK, March 18—Kerosene oil prices have to-day been increased 1 cent a gallon by the Standard Oil Co. of New York. This applies only to domestic consumption. The price of 150 test oil is now 18½ cents in barrels, and 12½ cents in tank wagons. Gasoline prices still remain unchanged.

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Firestone Heads New Rubber Co.

AKRON, O., March 18—R. J. Firestone, vice-president of the Firestone Tire & Rubber Co., is instrumental in the organization of a new rubber company which has already acquired the property of the Standard Tire & Rubber Mfg. Co. at Willoughby. Mr. Firestone will be president of the new company. Other officers are: Vice-president, C. A. McCulloch of the Parmalee Co., Chicago, and T. A. Palmer, former Diamond official, secretary and treasurer. Pneumatic and cord tires will be manufactured. The plant has a capacity of 250 tires a day.

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Ford Tractor Production Growing

DEARBORN, March 17—Henry Ford & Son have begun using the new shops south of the tractor plant. Within three months it is expected the production of the factory will be doubled. The new building, which was started for the production of small tanks or whippets on government account, affords 121,600 sq. ft. of floor space, and a building connecting it with the old plant gives 58,800 additional sq. ft. The plant is now producing 250 machines daily. Since the first tractor was produced 46,226 machines have been made.

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Urges Oil Industry to Co-operate with Government

WASHINGTON, March 17—A message urging continuance "in some effective way" of the co-operation between the nation's oil industry and the government, and emphasizing the value to the Allies of such co-operation during the war by the petroleum industry, was contained in a letter sent to-day by the United States fuel administrator, H. A. Garfield, to the National Petroleum War Service Committee.

Working Standards for Women

Recommended by Labor Department to Regulate Time and Pay

WASHINGTON, March 18—The Department of Labor recommends eight working standards for female labor which it expects will be incorporated and converted into national legislation some time in the near future.

The standards recommended are as follows:

1. An eight-hour day, no more than 48 hours in any one week.
2. Half holiday on Saturday.
3. One day of rest in seven.
4. At least three-quarters of an hour for a meal.
5. A rest period of ten minutes should be allowed in the middle of each working period without thereby increasing the length of the working day.
6. No woman should be employed between the hours of 10 P. M. and 6 A. M.
7. Women doing the same work as men shall receive the same wages with such proportionate increases as the men are receiving in the same industry. Slight changes made in the process or in the arrangement of the work should not be regarded as justifying a lower wage for a woman than for a man, unless statistics of production show that the output for the job in question is less when women are employed than when men are employed. If a difference in output is demonstrated the difference in the wage rate should be based upon the difference in production for the job as a whole, and not determined arbitrarily.
8. Wages should be established on the basis of occupation and not on the basis of sex. The minimum wage rate should cover the cost of living for dependents and not merely for the individual.

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More Case Business With Less Profit

RACINE, March 19—Although sales of the J. I. Case Threshing Machine Co. were $25,162,769 in 1918, which is an increase of $7,505,016 over 1917, net profits for the year were only $2,539 ahead of last. On Dec. 1, 1918, $274,000 first mortgage 6 per cent gold bonds matured and were paid. The company also retired during the year $2,532,000 of bonds not yet due, as well as writing off $807,076 European assets and reducing the inventory of second-hand machinery by $376,811.

Income account for the year ended Dec. 31, 1918, compares as follows:

	1918	1917	1916
Gross sales	$25,162,769	$17,657,753	$13,047,257
Net earnings	5,992,023	4,066,854	2,658,997
Interest	572,622	726,540	737,389
Dep. & amort.	807,246	290,933	273,887
Federal taxes.	850,000	275,000	.....
Bond pr. etc.	225,032	.....	.....
Extra charges	*1,183,888	417,608	.....
Net profits	$2,353,235	$2,356,773	$1,647,721
Preferred div.	850,500	850,500	850,500
Year surplus.	$1,503,735	$1,506,273	$797,221

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Brown Heads New York Dealers

NEW YORK, March 17—C. M. Brown was re-elected president of the Automobile Dealers' Assn. at its directors' meeting on March 10. W. C. Poertner and William Parkinson were re-elected vice-president and treasurer, respectively. The new board of directors consists of H. R. Bliss, Colt-Stratton Co.; C. M. Brown, The Winton Co.; H. J. DeBear, Maxwell Motor Car Co.; R. J. Gilmore, Packard Motor Car Co.; C. H. Larson, Cutting-Larson Co.; William Parkinson, William Parkinson Motor Sales Co.; W. C. Poertner, Poertner Motor Car Co.; A. G. Southworth, Buick Motor Co.; W. D. Stewart, Willys-Overland, Inc., and W. A. Woods, Van Cortlandt Vehicle Co. The association is planning to locate in headquarters suitable to be run on a club plan, with restaurant, reading and meeting rooms. It is also planned to have other automotive organizations use the rooms for their meetings, etc.

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Entries for Ascot Speedway Race

LOS ANGELES, March 18—Seven drivers have notified the Contest Board of the American Automobile Association of their intention to enter the 150-mile speedway race to be held on the Ascot Speedway here on March 23, in special cars. They are:

Driver	Car
E. J. Murray	Murray
John D. Harloe	Mercer
L. Melcher	Duesenberg
Roscoe Sarles	Roamer
A. H. Patterson	Hudson Super-6
Fred Newman	Newman
Omar Toft	Miller

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Chicago Pneumatic Tool Has $535,833 Surplus

CHICAGO, March 17—The financial statement of the Chicago Pneumatic Tool Co. of Dec. 31, last, shows a surplus of $535,833 after necessary deductions were made. Net profits after war taxes were taken out amounted to $1,283,213, as compared with $2,006,372 in 1917 before war taxes were charged off.

Balance sheet of Chicago Pneumatic Tool Co., as of Dec. 31, 1918, compares as follows:

ASSETS

	1918	1917	1916
Real estate, plant, etc.	*$7,662,177	$7,277,169	$7,190,686
Investments	58,309	1,191,370	1,191,370
Treas. stock.	.....	37,000	37,000
Treas. bonds.	.....	42,000	89,000
Liberty bonds	46,308	.....	.....
Cash	674,627	286,044	256,371
British Gov't securities	592,484	.....	.....
Accounts and bills receivable	2,799,373	2,428,911	2,023,612
Deferred charges	393,306	.....	.....
Inventories	4,961,094	4,291,553	2,873,910
Sink fund	31,161	1,719,434	1,116,596
Total	$17,218 839	$16,773,483	$14,778,545

LIABILITIES

Capital stock	$6,448,800	$6,485,800	$6,485,800
Bonds	3,250,000	2,500 000	2,500,000
Dividends payable	96,732	127,213	124,863
Accounts and bills pay'ble	2,175,401	2,549,894	1,685,760
Dividends unclaimed	1,224	.....	.....
Sinking fund reduction	.....	1,219,434	1,116,596
Accrued interest	56,413	.....	.....
Reserves	408,162	243,078	28,677
Surplus	4,782,107	3,648,063	2,836,849
Total	$17,218,839	$16,773 483	$14,778,545

*After reserve for depreciation.

The company formerly manufactured the Giant truck, but has been gradually getting out of this line.

Requirements of Tractors for Use in Southern States

Protection of Parts from Dust and Sand of Greatest Importance—Inclosure of Parts and Fitting of Dust Separator to Carbureter Necessary

(*By a Class Journal Staff Correspondent*)

MACON, GA., March 17—TO SUCCESSFULLY COMBAT SOUTHERN SOIL CONDITIONS, TRACTORS MUST BE EXCEPTIONALLY WELL PROTECTED FROM THE DUST EVIL. FOR RELIABLE, EFFICIENT SERVICE AND LOW UPKEEP EXPENSE THERE MUST BE A BETTER INCLOSURE OF WORKING PARTS THAN MANIFESTED ON CERTAIN MAKES OF TRACTORS.

A drive through the country surrounding Macon, Atlanta and other cities of Georgia convinces one that the sandy condition of the soil is going to play havoc with tractors if not guarded against. The general lay of the land and soil characteristics are ideally suited for working with the tractor, as was shown at the recent Dixie demonstration.

Nothing will make a tractor short lived so much as exposure of working parts to sand. It does not mean that only the engine parts should be inclosed, but those subjected to abnormal wear, as the steering gear, drive pinions, bull gears, wheel spindles, etc.

Air Cleaners Imperative in Southeast

Air cleaners are imperative on Georgia soil; in fact, in any of the soil of the Southeast. Although the demonstration field at Macon was not entirely dry while the plowing was going on, the dust at times was terrific.

If the tractor maker is going to stand behind his distributer and dealer in Dixie he will make sure his tractor is fitted with the best possible means for cleaning the incoming air on the carbureter, if service and maintenance cost are going to be stripped to bed rock.

Questioning the motor car dealers in this vicinity one finds the sandy condition of the soil gets in its destructive work on passenger car and truck engines to a greater or less extent. Thus there is considerable cylinder reboring going on throughout the cotton states.

Georgia sand when mixed with the oil in the crankcase of the tractor engine makes a cutting compound second only to emery and oil itself. Obviously bearing life under such influences is short.

But it is not only the engine we must go after. It is highly important that gears be inclosed as far as possible and provision made that sand will not come in contact with the surfaces of the bull pinion and gear if the tractor is of this type. The bull pinion and gears are subjected to very heavy loads as it is and their tooth surfaces will be rapidly cut down when sand gets between, no matter how well they are made or how hard the surfaces.

A cover should be put over the engine valve mechanism, with a good heavy gasket underneath, so that sand cannot get at the working parts. This also holds true of the governor parts. Rocker arms and such mechanism as may be employed for valve action travel very fast, and when sand gets into the bearing surfaces the resultant cutting action is just that much faster.

Owing to the hilly condition of the Southeast generally there is bound to be considerable pressure on the wheel bearings in addition to that set up by the pull of the plow, weight of the machine and other factors. IT MEANS THAT IF THE TRACTOR IS OF THE WHEELED TYPE, THE SPINDLES MUST BE PROTECTED BY SUITABLE DUST CAPS OVER THE HUBS. There must be a copious use of felt washers also, not only to keep the dust out but the lubricant in.

The bearing surfaces of the steering gear must not be overlooked, and makers might do well to fit leather boots over the joints of the tie rod and drag link, unless the tractor is operated by cables or chains.

Keep Sand Out of Gearsets

Inspection of some of the present day tractor transmission layouts shows that not sufficient thought has been put on the question of keeping sand out of the gearsets. On some designs the gear shifting shafts are exposed when the lever is in certain positions and at other times housed within the case. The result is sand collects on the ends of the shifting shafts and is carried into the case ultimately.

The combination of grease and sand on the shafts makes a gritty substance that enlarges the hole in the case through which the shafts work and gives the sand all the more chance to get in. A suitable cover of some kind, a light stamping or sheet iron cover with a gasket between it and the case will go a long ways toward eliminating transmission troubles from sand.

The above are some of the major things to be considered in the design of a tractor for the Southeast.

Government Investigates Tractor Use

WASHINGTON, March 17—The Bureau of Farm Management, Department of Agriculture, has compiled a pamphlet dealing with farm tractor experiences in North and South Dakota which will be ready for distribution within the next few weeks. Several hundred tractor owners in the Dakotas were asked these questions:

"What do you find to be the principal advantages of the tractor for farm work?"
"What are its principal disadvantages."

Saving in time, thus making it possible to cover the desired acreage within the proper season, is put first among the advantages by a large percentage of farmers. Other advantages mentioned are: Ability to do thorough work, especially in hot weather, when horses are at a disadvantage; saving in man power, doing away with more or less hired labor and enabling one man to farm larger acreage than he can with horses.

This last advantage is mentioned by a larger percentage of Dakota farmers than of farmers in other states where similar investigations have been made. This is doubtless because the system followed in the Dakotas is such that the tractor can be used to advantage for more of the farm work than in most other parts of the country.

The principal disadvantage of the tractor, according to the reports, is its injurious effect on moist soil. This difficulty is a serious one in districts where the soil is heavy and where it is necessary to do a considerable amount of work in early spring.

Difficulty of operation seems to rank next as a disadvantage. A large percentage of farmers emphasize it. Other disadvantages mentioned are expense of operation, undue increase in investment and delays on account of engine trouble.

In comparing the reports upon which this bulletin is based with those obtained from tractor owners in various parts of the corn belt several years ago it appears that less stress is laid upon the disadvantages of the tractor than in the older ones.

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Tractors for Road Work

HARRISBURG, March 15—Twenty-three tractors purchased by the State Defense Commission last spring to aid the farmers in plowing during the war have been turned over to the State Highway Department, to be used to drag the roads. This step has been taken by Frank B. McClain, executive director of the State Commission. He also has turned over twelve State-owned tractors, with plow attachments, to State institutions, for use on farms owned by the commonwealth. The remainder of the implements will be sold by the State. This means that the tractor leasing proposition was all very well last spring, to speed up the crops for war purposes, but there has been so little general response to another year of leasing the State's tractors on the part of the rural communities that the idea was abandoned.

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May Hold Next Detroit Show in March

DETROIT, March 15—The Detroit Automobile Dealers' Association at its next meeting will entertain a proposition to make the March date for the Detroit show permanent.

Savage Arms Doubles Earnings

Plant Quadrupled and Outstanding Bonds Purchased —War Work Is Finished

NEW YORK, March 17—During the year 1918 the Savage Arms Corp. doubled its net earnings, despite the fact that in that time more than $2,000,000 was expended for plant extensions and additions, all outstanding bonds as of Dec. 31, 1918, have been purchased and retired, amounting to over $3,000,000, and dividends amounting to $537,000 were paid. At the present time the ratio of current assets to liabilities is approximately 10 to 1; of $22,000,000 total assets, $15,000,000 are current.

In the company's annual report, President A. E. Borie points out that with the close of 1918 the war business of the company is practically at an end, and adds that of the various products made in the last 3 years the one which has contributed to the largest degree to the success of the company has been the Lewis machine gun. In these 3 years the company has more than quadrupled its plant facilities. Herewith is the annual statement:

SAVAGE ARMS COMPARATIVE INCOME ACCOUNT FOR THREE YEARS

	1918	1917	1916
Total earnings after deducting all expenses incident to operations, including those for ordinary repairs and maintenance of plants, ordinary taxes and ordinary depreciation charges which includes amortization of Patents, etc.	†$7,859,121.13	$5,227,749.31	*$3,289,710.75
Interest for year on outstanding bonds	24,397.33	63,630.35	88,827.67
	$7,834,723.80	$5,164,118.96	$3,200,883.03
Reserve for State and Federal taxes and contingencies	6,460,237.76	3,669,000.00	2,425,127.00
Balance	$1,374,486.04	$1,495,118.96	$775,756.08
Dividends	537,051.00	459,147.50	740,264.50
Added to surplus	$837,435.04	$1,035,971.46	$35,491.58

*Ordinary depreciation omitted.
†Includes super depreciation.
Note.—The operations for the year 1916 were carried on under the name of Driggs Seabury Ordnance Company.

CONDENSED BALANCE SHEET

Assets			
Plant:			
December 31, 1915		$3,950,213.22	
Additions and extensions to December 31, 1918		5,589,898.77	
		$9,540,111.99	
Less—Depreciation and amortization		3,956,061.95	$5,584,050.04
Patents, licenses, rights and good will		$7,142,248.07	
Less—Amortization		5,948,669.53	1,193,578.54
Investments			155,000.00
Current:			
Cash		$1,646,908.47	
Accounts and notes receivable—Less reserve		3,549,519.98	
Inventories—Less reserve		8,227,269.19	
United States Government certificates and bonds		1,830,750.00	
			$15,254,447.64
Deferred			39,141.43
			$22,226,217.65
Liabilities			
Capital stock:			
First Preferred	$500,000.00		
Less—Acquired and held in treasury	490,000.00	$10,000.000	
Second Preferred		260,700.00	
Common	$9,239,300.00		
Less—Acquired and held in treasury	1,281,300.00	7,958,000.00	
			$8,228,700.00
Current			1,592,507.40
Advances on contracts			362,927.15
Reserves:			
Taxes, royalties, insurance, etc		$7,917,617.63	
Special fund for contingencies		2,048,292.96	9,965,910.59
			2,076,172.51
Surplus			$22,226,217.65

Council Plan Adopted by Harvester

(*Continued from page* 658)

ence of action of employee representatives: the right of employees to recall unsatisfactory representatives—these are among the guarantees that the Works Council shall fulfill its intended function with even-handed justice.

VOTE ON HARVESTER INDUSTRIAL COUNCIL

Plant	Present and Eligible	Total Vote	For	Against
Deering	4103	4069	2100	1910
McCormick	5956	5795	2260	3056
Keystone	201	201	191	10
Auburn	1313	1291	1100	177
Akron	1069	1059	614	383
Milwaukee	4420	4387	3207	1096
Tractor	2244	2234	1005	1176
Springfield	544	540	480	54
Chatham	131	131	122	5
Plano	1051	1045	707	329
Weber	666	660	578	79
Hamilton	1855	1820	1849	152
Plow Works	743	732	623	86
Deering Twine	718	649	398	245
McCormick Tw.	831	781	308	432
Auburn Twine	364	364	332	25
St. Paul Twine	244	244	203	35
Steel Mills	1873	1863	1125	712
Iron Mines	*155	*149	128	21
Coal and Coke Works	644	597	428	167
	29,125	28,611	17,558	10,150

*Estimated.
Total spoiled and blank ballots, 903.

Petroleum Institute Organized

Oil Men of Three Countries Form Association to Promote Industry

NEW YORK, March 15—The American Petroleum Institute, in which membership is restricted to residents of the United States, Canada and Mexico, and which has for its objects the promotion of the petroleum industry throughout the world, and co-operation with the United States Government in matters relating to the development of crude oil production, was formed at a meeting held yesterday at the Biltmore Hotel.

The new body represents a development of the organization of the American petroleum industry for war service and it is intended that the association will be to its industry what the American Iron and Steel Institute is to the steel trade. For the first year the directors of the new body will consist of the 35 members of the National Petroleum War Service Committee.

At set forth in the by-laws adopted, the objects of the association are to afford a means of co-operation with the government in all matters of national concern, to foster foreign and domestic trade in American petroleum products, to promote in general the interests of the petroleum industry in all its branches, the mutual improvement of its members and the study of the arts and sciences connected with the petroleum trade.

S. A. E. To Meet With Detroit Engineers

DETROIT, March 12—The Detroit Section of the Society of Automotive Engineers will hold a joint meeting on March 21 with the Detroit Engineering Society, an organization made up of engineers in all industries. Elmer A. Sperry of the Sperry Gyroscope Co., Brooklyn, will deliver an address on the gyroscope in modern warfare. The meeting will be held at the Board of Commerce Auditorium, at 8 p. m.

Public Meeting of National Highway Association

NEW YORK, March 11—A public meeting of the National Highway Traffic Assn. will be held at the Automobile Club of America, 247 West Fifty-fourth Street, on Friday, March 21, at 8 p. m. The program includes talks on the following:

"Qualifications for Operators of Motor Vehicles and Revocation of Licenses," by the Hon. Francis M. Hugo, secretary of the State of New York.

"Regulation of Pedestrian Traffic," by Dr. Shirley W. Wynno, assistant registrar of Records, Department of Health, New York City.

"Sign Posting for Detours and Through Routes in Municipalities," by Elmer Thompson, secretary of the Automobile Club of America.

The report of the Committee on "Gen-

eral Highway Traffic Regulations for Drivers with Directions for Pedestrians" will be presented by William P. Eno, chairman, who is also chairman of the Highways Transport Committee, District of Columbia.

An informal dinner at $1.50 a cover will be served in the grill room of the club at 6:30 p. m.

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New Motor Fuel Evolved

WASHINGTON, March 13—Development too late for use in war time of a motor fuel which adds 10 miles an hour to the speed of airplanes, and has possibilities for use in automobile racing was announced yesterday by the Bureau of Mines. The liquid, a combination of benzol and cyclohaxane called hector, costs about $1 a gallon. While of military value, it is not regarded as practical for commercial purposes at present.

Another combination developed by the bureau, consisting of benzol and gasoline, has been found to be more powerful than gasoline alone, and is expected to prove of value in industry. The comparative scarcity of benzol makes its production to supplant gasoline on a large scale improbable in the near future.

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Process for Motor Fuel on Market

ST. JOSEPH, MO., March 15—The Motor Fuels Co., which has a process for producing motor fuel for internal combustion engines from fuel oil, developed by S. M. Herber, president of the company, is placing its process on the market. The fuel, it is claimed, can be made at a cost not to exceed 6.5 cents per gal. from fuel oil valued at 80 cents per bbl. at the refinery and which tests from 24.5 to 28 gravity Baumé, after all kerosene and gas oil products have been distilled out by the usual methods, or from crude oil of the same character. This motor fuel, it is said, will stand as high in a test of efficiency as the 58 to 59 gravity gasoline now sold and used by the general public. Mr. Herber is willing to conduct demonstrations and tests as may be mutually agreed upon at the model plant here, and is ready to enter into contracts to demonstrate the process.

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To Reduce Freight Rates

WASHINGTON, March 13—Complete co-operation with the manufacturer for the purpose of encouraging and promoting export trade is forecast by the announcement of the Railroad Administration that new decreased rail rates to the Pacific, South Atlantic, and Gulf ports will soon be made public. This Shipping Board will, at about the same time, announce lower ocean shipping rates. The Department of Commerce, United States Shipping Board and the Department of State have worked hand in hand in this matter and are conferring with important exporters.

The object of the reduction in ocean and railroad rates is to meet the competition of Great Britain, which can only be done by substantial reductions in these charges.

Jobbers Want Tax in Price List

Pass Resolution for Price Revision—Makers Hand Tax on to Jobbers

CHICAGO, March 17—Dealers and jobbers of automobile accessories are beginning to get fairly well set on how they should handle the new revenue tax. The tax, of course, must be passed on to the consumer where it is not absorbed by the manufacturer. However, the government does not desire that the additional amount should be passed on to the dealer by the jobber or to the consumer by the dealer as a tax item, but rather that it be included in the list price. An incomplete census of the accessory manufacturers by the Automotive Equipment Association, formerly the National Association of Accessory Jobbers, seems to show that very few manufacturers are absorbing the tax. Most of them are passing it on to the jobber, as a tax item, and the jobber is supposed to change his prices accordingly.

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COLUMBUS, March 17—The Ohio Automotive Equipment Jobbers' Association to-day recommended that the manufacturer of equipment pay the war tax. The jobbers do not want the job of passing it along in the form of a tax. If the present list prices are not high enough to permit the manufacturer to pay the tax the jobbers request that the lists be revised to cover the increase. The tax is 5 per cent, and is laid on the manufacturer. Some manufacturers have passed it along in tax form, which procedure has not generally met the approval of the jobbers.

Those represented at to-day's meeting at the Hotel Virginia were: Justus & Parker Co., Columbus; Griswold-Sohl Co., Columbus; J. I. J. Cooper Rubber Co., Cincinnati; Ohio Rubber Co., Cincinnati; Dine-DeWees Co., Canton; York Supply Co., Greenville; Pennsylvania Rubber & Supply Co., Cleveland; C & D Auto Supply Co., Cincinnati; Union Supply Co.. Toledo; Ohio Rubber Co., Cleveland. The president is H. M. Dine, Canton, and the secretary, H. S. Bender, Toledo.

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NEW YORK, March 18—Supplementing a resolution passed by the Eastern automobile accessory jobbers at a meeting here on March 10, in which it was recommended that automotive accessory manufacturers absorb the 5 per cent Federal excise tax and make returns direct to the government, the following resolution has been unanimously passed:

Resolved, That the jobbers of the metropolitan district recommend that the manufacturers of automobile accessories absorb the 5 per cent Federal excise tax, and if necessary, revise the selling schedule to enable the jobber and dealer to resell goods without any mention of the tax.

At that meeting an open discussion was held at which some sixty representatives of manufacturers of automotive accessories were present. A number of them decided to absorb the tax without changing the prices. Others decided to absorb the tax and revise the selling schedules by increasing the prices. Another decision was to the effect that the 5 per cent tax would be simply added to the invoices as a tax.

The following jobbers were present and in favor of the resolution: Auto Supply Co., Beckley-Ralston Co., Julius Bindrim, Economy Auto Supply Co., Farrell Auto Supply Co., King Tire Co., Lowe Motor Supplies Co., Martin Evans Co., Motor Car Equipment Co., Oriental Rubber & Supply Co., A. J. Picard & Co., Inc., W. E. Pruden Hardware Co., Ready Auto Supply Co. and the Whittemore-Sim Co.

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Labor Board Decisions Favor Employees

WASHINGTON, March 13—That the government recognizes the right of employees to organize and bargain collectively is indicated in a recent decision of the National War Labor Board in the cases of the machinists versus the Russell Motor Car Co., Buffalo; the Detroit Forging Co., Detroit; American Wood Rim Co., Oanway, Mich., and the International Association of Machinists versus the Linderman Steel and Machinery Co.

In the Linderman company findings the Board decided that the machinists have the right to organize as well as the employers and may bargain collectively through their chosen representatives. Employers cannot discharge workers because of membership in trade unions or for legitimate trade-union activities.

In the case of the American Wood Rim Co., recognition to organize and to bargain collectively was granted, and the company was instructed to recognize and deal with the workers. A like finding was made in the case of the Detroit Forging Co.

In the case of the machinists versus the Russell Motor Car Co., the National War Labor Board ordered the company to recognize the right of the employees to organize and to reinstate several employees, with full pay, who had been discharged for refusing to accept the piece-work system. The company agreed to abolish the piece-work system if so demanded by a majority of the workers.

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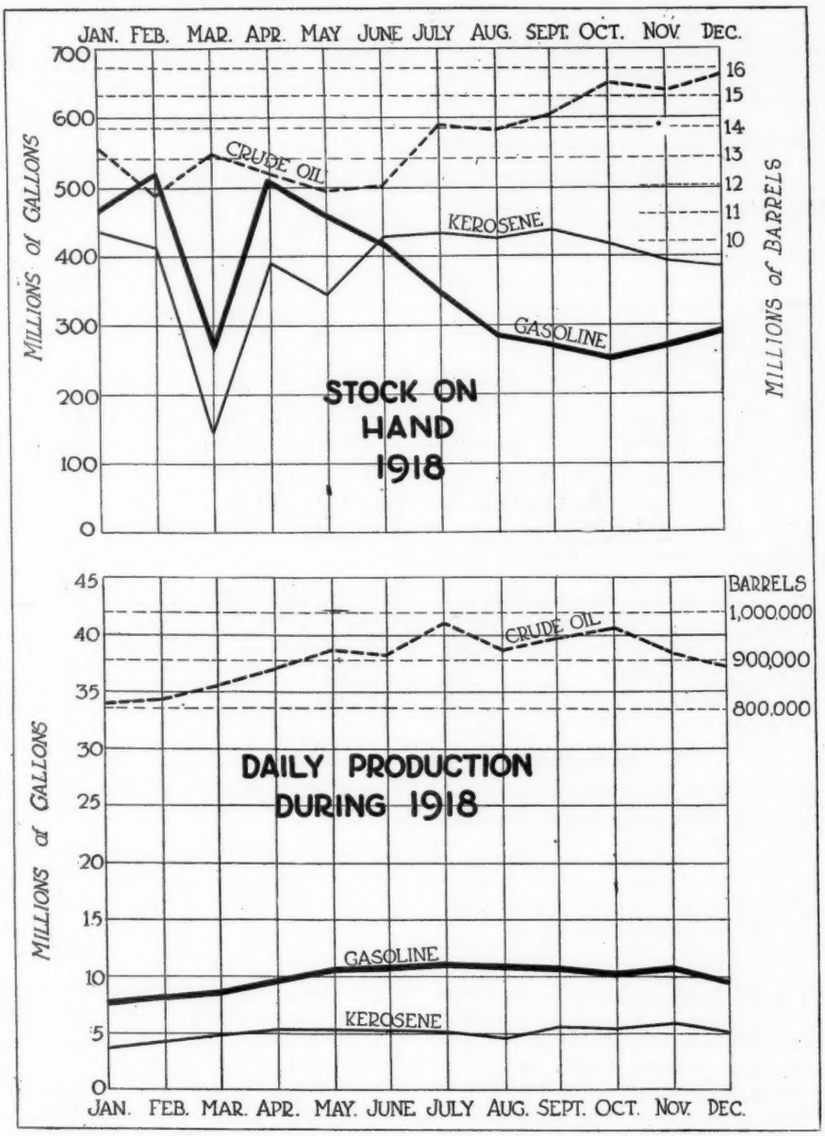
General Motors to Help Build Lincoln Highway

NEW YORK, March 17—W. C. Durant, president of the General Motors Corp., will contribute $100,000 out of the company's funds for the construction of the last remaining bad stretches of the Lincoln Highway. These are east of Fallon, Nev., in Churchill County. There is one stretch of 12 miles in the Fallon sink which will require an expenditure of $60,000, together with a similar amount from the government. Another stretch of 8 miles at New Pass, Nev., in White Pine County, will take the remaining $40,000 for repairs. With the completion of these repairs, all of the bad stretches between Cheyenne, Wyo., and Reno, Nev., will have been abolished.

Petroleum Products Stock and Production for 1918



25 Per Cent Gain in Gasoline

1918 Figures Show Increases in Production of Kerosene and Crude Oil

PRODUCTION

	November, 1918	December, 1918
Crude oil (bbl.)	27,411,636	26,958,157
Gasoline (gal.)	312,968,640	291,744,465

	Stocks on Hand Nov. 30, 1918	Stocks on Hand Dec. 31, 1918
Crude oil (bbl.)	15,222,401	15,749,771
Oils purchased to be re-run (bbl.)	1,373,740	1,300,018
Gasoline (gal.)	270,072,011	297,326,983
Kerosene (gal.)	397,804,012	380,117,829
Gas and fuel (gal.)	583,777,918	359,001,357
Lubricating (gal.)	132,923,478	138,853,574
Wax (lb.)	190,953,158	199,657,542
Coke (ton)	22,005	22,605
Asphaltum (ton)	74,955	76 858
Miscellaneous (gal.)	466,887,345	477,783,740

NEW YORK, March 17—Gasoline production increased 25 per cent in 1918. The latest figures from the Bureau of Mines show an increase of 719,766,540 gal. in 1918 over 1917. Crude oil production increased 3 per cent, or a gain of 10,892,949 bbl. over 1917. Kerosene production was 5 per cent higher, or 98,591,161 gal., more than in 1917.

The average daily increases show 2,136,349 gal. for gasoline, 270,112 gal. for kerosene and 29,870 bbl. for crude oil.

The gasoline production for the entire year of 1918 was 3,570,312,963 gal., that of kerosene was 1,825,360,137 and of crude oil 326,024,630 bbl.

The greatest production occurred in the months included between April and October. These figures include production of gasoline, kerosene and crude oil.

The average daily production of gasoline, kerosene and crude oil in December, 1918, kept pace with the previous month. Though there is a slight decrease, this is explained by the fact that there is one more day in December. Comparing the December daily production figures with

Output of Refineries in the United States by Months During 1918

Total Output of Refineries in the United States for 1917

1917	Crude (bbl.)	Other Oils (bbl.)	Gasoline (gallons)	Kerosene (gallons)	Gas and Fuel (gallons)	Lubricating (gallons)	Wax (pounds)	Coke (tons)	Asphaltum (tons)	Miscellaneous (gallons)	Losses (bbl.)
January	24,839,772		203,618,724	137,248,370	469,596,208	60,941,062	39,558,627	44,627	49,894	27,331,019	941,924
February	23,083,433	no account	184,602,595	129,074,504	446,964,925	54,631,765	36,370,297	42,047	40,619	23,685,686	941,110
March	26,230,138	1st 6 mo.	220,523,571	159,028,978	494,855,838	64,345,221	40,868,930	48,839	52,823	26,977,334	870,380
April	25,994,938	1917	228,945,164	157,826,945	462,846,339	63,218,215	41,037,511	46,099	52,849	30,959,901	957,533
May	27,253,391		238,816,209	147,894,846	504,859,695	65,926,007	38,686,364	43,535	67,612	31,086,377	979,245
June	26,453,210		233,671,746	151,477,333	496,742,434	61,045,757	38,075,280	42,513	67,931	30,205,172	1,011,568
July	26,776,856	2,435,533	244,145,292	161,679,053	599,454,966	64,335,905	40,158,033	42,641	65,272	92,359,401	1,111,511
August	27,900,623	2,376,580	254,464,491	149,528,513	632,151,971	64,107,817	38,999,341	46,240	73,878	92,708,312	1,286,141
September	27,529,022	2,632,988	256,132,050	143,203,644	629,914,572	60,757,049	48,300,033	42,986	62,520	80,386,471	1,182,560
October	27,698,023	2,863,518	271,891,234	140,559,542	621,492,374	68,516,071	41,181,400	48,849	73,886	91,804,160	1,355,219
November	26,215,979	2,519,700	264,888,709	125,893,202	592,490,037	64,861,375	39,694,595	45,815	73,289	87,115,002	1,203,110
December	25,155,996	2,069,351	248,846,638	123,354,046	561,954,921	61,090,596	38,269,670	45,175	58,852	87,548,408	1,233,528
Total	315,131,681	14,897,670	2,850,546,423	1,726,768,976	6,513,324,280	753,776,840	481,200,081	539,366	739,425	702,167,243	13,073,829
January	23,842,587	2,300,334	242,632,044	119,358,184	547,866,248	56,623,425	39,238,858	41,216	54,854	70,995,829	1,078,181
February	23,386,676	2,298,333	234,324,619	121,218,320	510,165,397	58,300,914	35,087,337	42,371	42,033	75,134,088	983,992
March	26,239,662	3,696,872	269,627,968	151,228,007	587,985,804	69,308,351	43,597,019	44,248	56,901	94,865,148	1,097,489
April	26,201,544	3,956,244	293,396,162	153,703,682	578,255,341	71,022,204	40,173,524	45,674	51,242	89,242,012	1,182,020
May	28,510,698	4,112,023	319,391,202	160,590,760	631,586,209	79,589,735	42,544,633	48,864	60,449	88,627,491	1,269,281
June	28,140,479	3,483,270	315,023,445	151,840,252	628,842,033	74,420,996	41,317,794	46,605	50,321	81,110,922	1,282,177
July	29,170,718	5,951,537	332,022,095	156,828,826	658,439,682	79,303,107	41,691,551	48,914	58,433	159,374,139	1,338,304
August	28,534,275	6,376,353	330,335,046	149,678,850	671,113,871	72,892,879	41,829,516	51,759	59,715	163,345,034	1,337,327
September	28,390,431	5,485,747	314,595,959	164,963,798	653,085,050	70,593,079	42,704,894	48,052	49,157	138,201,963	1,236,834
October	29,237,767	5,571,847	314,251,318	164,928,640	661,780,441	72,244,633	43,470,132	48,820	51,878	166,109,867	1,161,545
November	27,411,636	3,857,754	312,968,640	169,278,105	604,403,494	72,178,602	49,642,007	51,393	35,387	75,430,160	1,236,818
December	26,958,157	3,474,890	291,744,465	161,742,713	587,873,987	64,987,842	43,847,092	41,747	37,596	84,273,730	1,352,657
Total	326,024,630	50,565,204	3,570,312,963	1,825,360,137	7,321,397,557	841,465,767	505,144,357	559,663	607,968	1,286,710,383	14,556,625

those of the same month in 1917, there is disclosed the fact that our production is now on a much higher scale. Our kerosene and gasoline stocks on hand, however, still remain in an unsatisfactory condition, as compared with 1917. The figures, however, for December show a 10 and 4 per cent increase for gasoline and kerosene, over November, 1918. The production of crude oil in December, 1918, though lower than November, was still at a higher level than the year previous.

This winter has been so favorable for motoring that an increase in the consumption of gasoline and oils can be expected. As a result the figures for January, February and March will probably not compare favorably with those for the same months in 1917.

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Prices of British Cars Increase

LONDON, March 4—(Special Correspondence)—The prices of British cars are steadily increasing. The Austin, which recently sold for $2000, is now $2,475, with no deliveries promised until August. The average pre-war British car selling at about $1750, is being continued in its pre-war design in order to use up old stocks and also as an easier proposition for re-starting manufacture at prices varying from $2250 to $2375. The Rover Co., which produces the most popular medium-priced car, answers inquiries with regard to post-war production and prices with the statement that no information is available at present, and that the company cannot speak with regard to deliveries or prices.

The fuel situation is still obscure. On some sides it is claimed that there are ample supplies of fuel, but that the complicated system of government control, under which gasoline can be purchased only by means of a license, is to blame. However, inasmuch as licenses for almost unlimited quantities are granted to practically everyone, it would seem that there is no question of a shortage of supplies.

Licenses cost at the rate of 12 cents a gallon. Up to Feb. 4 the same license was required for the purchase of benzol, but on that date the government rescinded the order requiring such a license, and in consequence there has been great rush by everyone to obtain supplies. At present the price of benzol is artificially raised and kept at the same level as gasoline.

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May Sell Army Trucks

WASHINGTON, March 15—In view of the decreased size of the Motor Transport Corps and the entire army, as provided for by proposed legislation, it is now considered possible that a number of war trucks may be sold. The National Automobile Chamber of Commerce has already informed the War Department that it desires first knowledge of any proposed sales and the opportunity to work out some scheme whereby the manufacturer will be protected. The Motors Vehicle section of the army has assured the N. A. C. C. that it will co-operate with the industry.

Cancellations and Suspensions of Aircraft Contracts

The following is a summary of cancellations and suspensions of aircraft contracts to Feb. 7:

	Value	Per Cent of Total
Engines and spare parts	$250,107,551	53
Planes and spare parts	163,231,790	35
Chemicals	*13,181,285	3
Balloons and balloon supplies	*9,877,356	2
Instruments and accessories	*$9,864,238	2
Fabrics, lumber and metals	*5,954,726	1
Miscellaneous	16,631,047	4
Total	*$468,847,993	

*Reductions due to revision in cancellations of contracts.

SUSPENSIONS OF PLANE AND ENGINE CONTRACTS

The value of planes and engines delivered during the week ended Feb. 7 was nearly $2,000,000, leaving a balance on order valued at over $10,000,000.

	Balance on Order Nov. 11	Suspended Nov. 11 to Feb. 7	Per Cent Suspended	Per Cent Delivered	Per Cent Remaining
Planes:					
Service	$124,818,750	$113,968,750	91	8	..
Advanced training	12,203,600	9,677,700	79	18	3
Elementary training	5,400,000	4,187,358	77	23	..
Total	$142,422,350	$127,833,808	90	9	..
Engines:					
Service	$227,010,000	$193,452,000	85	14	..
Advanced training	31,377,500	14,926,295	48	27	25
Elementary training	2,864,200	.....	..	93	7
Total	$261,251,700	$208,378,295	80	17	3

331 Liberty Motors Remaining on Order

During the week ended Feb. 7 a total of 189 Liberty motors were delivered, leaving 331 still on order. To date 20,147 have been produced.
The status of contracts on Feb. 7 is shown below:

	Balance on Order Nov. 11	Suspended Nov. 11 to Feb. 7	Delivered Nov. 11 to Feb. 7	Per Cent Suspended	Per Cent Delivered	Per Cent Remaining
Nordyke-Marmon Co.	4,548	4,000	548	88	12	..
Lincoln Motor Corp.	13,228	10,500	2,728	79	21	..
Packard Motor Car Co.	7,373	5,600	1,473	76	20	4
General Motors Corp.	3,430	2,472	927	72	27	1
Ford Motor Co.	1,947	1,050	897	54	46	..
Total	30,526	23,622	6,573	77	22	1

42 De Havilland 4 Planes Remaining on Order

Deliveries of De Havilland 4 planes during the week ended Feb. 7 were 5, leaving 42 still on order. A total of 4600, exclusive of 204 shipped without engines, have been produced.
The status of contracts on Feb. 7 is shown below:

	Balance on Order Nov. 11	Suspended Nov. 11 to Feb. 7	Delivered Nov. 11 to Feb. 7	Per Cent Suspended	Per Cent Delivered	Per Cent Remaining
Standard Airc. Corp.	421	360	61	86	14	..
Fisher Body Corp.	3,031	2,400	631	79	21	..
Dayton-Wright Airplane Co.	2,623	1,900	681	72	26	2
Total	6,075	4,660	1,373	77	22	1

WASHINGTON, March 15—Cancellations of aircraft contracts aggregating $468,847,993 have been made by the War Department. Liberty engine production amounted to 20,147 and 331 are still on order.

When the armistice was signed there were 30,526 on order, and since that time contracts for 23,622 of these have been cancelled.

Deliveries from Nov. 11 to Feb. 7 totaled 6573, distributed as follows: Nordyke & Marmon Co., 548; Ford Motor Co., 897; General Motor Corp., 927; Packard Motor Car Co., 1473, and Lincoln Motor Corp., 2728.

Production of Haviland 4s, exclusive of 204 shipped without engines, amounted to 4600. There are still 42 on order. Deliveries between Nov. 11 and Feb. 7 were 61 from the Standard Aircraft Corp., 631 from the Fisher Body Corp. and 681 from the Dayton-Wright Aircraft Co.

Airplanes in Storehouses

WASHINGTON, March 19—Eight hundred and twenty-nine airplanes and 7315 engines have been shipped to storehouses since the date of the armistice by the Bureau of Aircraft Production. Types include the Liberty, OX-5, LeRhone, Hispano 180 and Hispano 150 engines, and DeHaviland, JN6-H and JN4-D planes. Following is the tabulation:

Liberty 12-service engines	4,806
OX-5 elementary training engines	1,261
Le Rhone advanced training engines	994
De Havilland 4 observation planes	524
Hispano 180 advanced training engines	343
Hispano 150 advanced training engines	254
JN6-H advanced training planes	174
JN4-D elementary training planes	131

Aeronautic Convention Starts May 1

NEW YORK, March 18—The second Pan-American aeronautic convention and exhibition will be held at Atlantic City, N. J., on May 1 and will last until June 1. The convention will be under the auspices of the Aero Club of America, the Aerial League of America and the Pan-American Aeronautic Federation. A program outlining each day's activities has been issued.

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Air Mail Service for France

PARIS, Feb. 20—Aerial mail service for Paris and other important French cities has started. The fliers carry mail between Paris and Bordeaux, Marseilles, Toulouse, Brest and St. Nazaire.

U. S. Ships Are Back on High Seas

Shipping Board Gives Figures Showing Positions as on January 31

NEW YORK, March 17—According to tables prepared by the Shipping Board's Division of Planning and Statistics, there were employed in overseas service under the American flag a total of 752 vessels, having an aggregate capacity of 1,961,239 gross tons. At that date American ships represented 46 per cent of all the shipping plying between United States and foreign ports, as against 9.7 per cent at the opening of the war. Although the following table represents the grouping of these vessels as at Jan. 31, 1919, it is understood that there has been considerable rearrangement and diversion of routes since that date, owing to the pressing need for foodstuffs in Europe.

Service	No. of Vessels	Gross Tons
Trans-Atlantic:		
West African	13	14,034
South African	24	33,793
East African	1	3,350
British	13	58,685
French	23	89,462
Belgian Relief	4	23,213
Italian	25	119,587
Swiss	1	1,965
Spanish	3	7,271
Portuguese	7	23,142
Other Mediterranean	9	16,974
Northern neutrals	2	12,606
Other trans-Atlantic	1	2,246
Trans-Pacific:		
East Asian	49	162,304
East Indian	5	13,279
British Indian	3	12,502
Australian	71	83,423
Hawaiian	17	43,416
South American:		
Amazonian	27	22 830
Central Brazilian	44	87,385
River Plate	39	99,488
West Coast	70	193,018
Carribbean and Mexican:		
West Indies	168	400,055
Caribbean	63	147,419
Mexican Pacific	2	2,262
Mexican Gulf	42	211,516
Alaskan	14	30,891
Canadian:		
Pacific	9	20,860
Atlantic	3	24,263
Overseas total	752	1,961,239

Factors in High-Speed Engine Development

(*Continued from page* 627)

Two sets of contacts arranged to fire alternately have been used, but this makes it necessary to re-time or adjust contacts frequently, as half of the cylinders might be late in firing, which would cause a heated engine and the other half of the cylinders early in firing, would cause premature or spark knocking.

It would be impracticable to enlarge the contact area, because of the inertia at high speeds, as even the lightest contact arrangement is too heavy for high-speed work.

If there is any eccentricity of cams and looseness of bearings with one set of contacts, those errors are very noticeable in the firing balance of the engine, but with the two sets of contacts 180 degrees apart, the ignition is perfectly synchronized, a fact which is very noticeable indeed in the firing balance of the Cadillac engine on block test.

I believe that the ignition as applied to the eight-cylinder Cadillac engine, which is patented, has been brought to a higher state of perfection than any other ignition, as so synchronized is this ignition that my company gladly loaned it to the Government for use on the Liberty engine, as without this system, I do not believe that the Liberty engine would have been so successful as it has been. Fig. 10 shows the system, the patent number being 1,286,803.

Some curves showing degrees of spark advance on the flywheel relative to r.p.m. are shown in Fig. 11 and are self explanatory.

One can appreciate some points in connection with the inertia of the contacts, because when running an eight-cylinder engine at 3000 r.p.m., an examination of the time taken between contacts is interesting, consuming the vast time of .005 seconds; at 3550 r.p.m. the time taken is 0.0042 seconds; at 3850 r.p.m. the time taken is 0.0039 seconds. With this in view it can readily be understood that very little variation can be allowed so that we prescribe an error of only one degree between the cylinders on our engines at all speeds.

Proper System Reduces Labor Turnover

(*Continued from page* 621)

Summarizing the turnover, we find four principal causes of separation—discharges, lay-offs, military service and quits, with the latter accounting for approximately 75 per cent of the evil. Inquiring into the causes for quits, it was found that 33 per cent were dissatisfied with wages, 27 per cent dissatisfied with "too hard work," 20 per cent declared the working conditions disagreeable, 8 per cent left to accept another position, 2 per cent quit because of monotony of work, 2 per cent for military service, and 8 per cent for miscellaneous reasons.

Causes for discharges included 27 per cent for insubordination, 24 per cent for laziness, 20 per cent for misconduct, 11 per cent for incompetence, 10 per cent for trouble making, 3 per cent for general unreliability, 3 per cent for drinking, and 2 per cent for other causes.

France Subsidizes Farm Machinery

PARIS, March 15—To encourage the use of agricultural tractors, the French government offers a subsidy of 50 per cent of the purchase price on all tractors and steam or electric plowing mechanism which are purchased by co-operative groups of farmers or by municipal authorities for general use. This 50 per cent subsidy is only granted when a purchase is made of not less than five tractors, or equivalent mechanical plowing material. When the purchase is less than five tractors the subvention cannot exceed a quarter or one-third of the price of the material, according to the condition of the persons making the purchase. An exception is made for farmers living in the devastated regions who can, under certain circumstances, receive 50 per cent subsidy.

Films an Incentive to Foreign Trade

Motion Picture as Trade Stimulator Urged by Department of Commerce

WASHINGTON, March 18—The use of moving picture films for the development of American industries in foreign countries has been taken up by the Department of Commerce. An appropriation of $69,000 for this work asked for by the department failed to go through Congress during the recent filibuster. Requests have already been received from American attachés for films, especially from China. Reports say that the use of motion pictures in that country would aid extensively in developing American trade there. Suggestions from the American office there include films showing American highways, farm tractors, passenger cars and motor trucks, including complete production of tractors, cars and trucks, and their operation on farms and roads.

Effective Method for Chinese

"The motion picture is one of the very effective ways of impressing American standards, material, equipment and methods on the Chinese," says the report received, "and films would be welcomed, showing construction and completion of American roads. A good film showing the entire process of the manufacture of automobiles and vividly picturing the advantages to the purchasing public of quantity production could be advantageously exhibited."

Owing to the fact that the bill did not pass, the Department of Commerce is asking manufacturers to supply it with films which will be at once forwarded to China and other countries. A translator and film expert are located at the department, who will adapt films for the particular countries to which they are sent.

Advantages to Great Britain and Canada

In discussing this subject with the Congressional Committee, the Department of Commerce pointed out that other nations, and particularly Great Britain and Canada, have found the motion picture an excellent means of promoting trade. Canada expended $40,000 for this work during February. As far back as 1913 Great Britain exhibited moving pictures of leading British industries in Europe, Canada, United States and South America.

Many, and in fact most, of the moving picture films exhibited throughout the world showing the United States are of the "Wild West" character, and instead of giving a fair representation of existing conditions they distort foreign impression. To counteract, and at the same time develop American foreign commerce, the department is urging this motion picture propaganda.

How Germany Sells Her War Vehicles

Organization of Manufacturers to Help Stabilize Motor Industry

WASHINGTON, March 17—In Germany, according to a consular report, twenty automobile manufacturers organized in 1915 for the purpose of taking over motor vehicles released by the army, and disposing of them so as to create the least disturbance to the automobile industry. The organization was known as the Feldkraftwagen Aktien-Gesellschaft, or Feldag.

It was generally expected that the automobile market would be flooded after the war, but according to an article in the Frankfurter *Zeitung* for Dec. 20, 1918, of which this is a summary, there is not the slightest danger of any immediate flooding of the market, in view of the great scarcity of repair parts. Even in the case of passenger vehicles, the present supply, especially of the lighter models, is far below the demand, and sales are now restricted to customers who need the vehicles for the performance of their professional duties, like physicians and veterinarians.

Some of the passenger vehicles of foreign makes were disposed of to neutral countries during the war, on account of the difficulty of securing duplicate parts. The Feldag is endeavoring to sell the vehicles only after having put them in good running order. But as under the present labor conditions repairs require much more time than under normal conditions, and in view of the scarcity of storage facilities, it was found necessary to sell limited numbers of unrepaired vehicles.

Private Orders Annulled

The apprehended drop in prices has also failed to materialize, especially in the case of commercial vehicles. A 3-ton truck which sold for about 16,500 marks ($3927) before the war and which may now be obtained for not less than 30,000 marks ($7200), with tires of iron and wood, is now sold by the Feldag, after a thorough overhauling, for 12,000 ($2880) to 14,000 ($3360) marks.

The fact that army contracts for about 10,000 trucks are still outstanding has also a steadying effect on the market.

Under the circumstances it is not surprising that private firms find it difficult to purchase trucks at reasonable prices. It is recalled that a few months ago the association of automobile manufacturers decided to annul all private orders for vehicles received prior to Dec. 31, 1916, on account of the abnormal increase in wages and materials. While orders are now accepted again by the manufacturers, the scarcity of raw materials and the general uncertain conditions make it necessary for them to stipulate a delivery period of several years and to protect themselves thoroughly in regard to prices.

Prior to the war it is estimated Germany had probably about 7000 to 8000 trucks in use. At the outbreak of the war most of them were taken over by the army, and during the war only about 2000 to 3000 vehicles assigned to the home forces were available, partly for public and partly for private use. An increase through return of army trucks is not to be expected, in view of the fact that their number was much smaller than it was generally anticipated, and also because of the armistice provision for the surrender of 5000 trucks to the Entente.

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Mexico Breaks Oil Pact

WASHINGTON, March 12—President Carranza has demanded immediate payment of "royalty taxes" on oil produced in Mexico in January and February despite his agreement with the United States to take no further action in Mexican oil matters until the Mexican congress could act on a new oil law.

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France May Import Tractors

WASHINGTON, March 15—The French Government will allow the importation of farm tractors from the United States provided commercial credits for one year can be arranged. Details of the plans are not yet known. The only advice received so far is a cablegram from Bernard M. Baruch stating: "The French Government is willing to allow sales to French merchants of $40,000,000 worth of machine tools and all agricultural implements if commercial credits for one year can be arranged."

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Copper Producers to Market Government Surplus

WASHINGTON, March 18 — Copper producers have arranged with the War Department to market the government surplus copper at the prevailing market prices, charging the government the actual cost of so doing. It will be distributed with the producers in connection with their own products, the minimum monthly amount being fixed, and the actual amount disposed of being a certain percentage of total sales exceeding the minimum amount. It was also agreed that the copper be entirely distributed within 15 months.

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Permanent Exhibit of War Materials

WASHINGTON, March 17—The Engineering and Standardization Branch of the Purchase, Storage and Traffic Division of the Army will establish and maintain an exhibit of standard war equipment and supplies. The exhibit will contain samples of all varieties of standard articles necessary for war, and is especially intended for the information of manufacturers, and in order to have available at all times approved samples or specifications of samples needed to facilitate production. A list of the articles which will be placed in this permanent exhibit will be made public later.

Improve Wood for Aircraft

New Methods for Seasoning and Testing Developed by Forest Laboratory

WASHINGTON, March 18—The use of plywood in aircraft construction and the development of improved kiln-drying are reported as a result of experiments by the Forest Products Laboratory, Department of Agriculture. One of the most important achievements was the discovery of a method to dry spruce in 30 days as compared with the two years heretofore required.

At the time our aircraft program was launched practically no seasoned spruce stock was available. To air-dry green spruce 3 in. thick, such as is used in airplanes, requires from one to two years. The Forest Products Laboratory specified a method of kiln-drying by which green spruce airplane stock can be dried in from 20 to 40 days to the proper moisture content. Kilns were designed for the Army and Navy and for commercial companies capable of properly drying airplane stock, and men were furnished to operate them until operators could be trained at the laboratory. Seasoned stock was thus insured equal, if not superior, to air-seasoned material.

A relatively slight advantage in lightness and strength over the best substitute makes spruce the preferred airplane wood and warranted the organization of a Spruce Production Division. The same importance attaches to any saving in strength, however slight, that is accomplished through proper methods of seasoning. Exhaustive tests are showing that the Forest Service specifications produce better material than can be secured by drying in the air.

Strength of Airplane Woods

Over 300,000 tests made on about 130 species of wood afforded basic information for aircraft design. From these data the relative suitability of various species of wood, the influence of defects, the relation between strength and density, and the influence of moisture can be determined. A table of strength values at 15 per cent moisture was prepared by the forest products laboratory, and adopted by the Army and Navy as a basis for the design of the wooden parts of aircraft.

Tests of Beams and Struts

On account of the difficulty in securing suitable pieces for manufacturing the larger airplane parts and the necessity for conserving material, several series of tests were conducted at the laboratory on built-up beams and struts of various designs and also on various types of splices. Present specifications of the Army and Navy for laminated and spliced beams and laminated struts are based on the results of these tests.

Automotive Conditions in England

War Has Opened Question of Air and Road Transportation and Government Control

LONDON, March 1—Pending a definite ending of the war, certain regulations of the Defense of the Realm Acts (commonly styled D. O. R. A.) continue to be operative. Under these powers the competent authorities have placed a temporary embargo on certain arranged for and other tentative and more or less experimental efforts to commercialize services by aircraft.

The Position of Aircraft Manufacture

One of the problems of the hour concerns the future of aircraft manufacture. For some time to come no stable commercial output of aircraft seems possible, if only for lack of data and experience of the sort of machines required. Aircraft for the naval and military forces and for postal work has a recognized place, and forms part of the Government's program for land and sea defense.

There is a rumor that certain aircraft factories will remain more or less under control of the state; though possibly not wholly excluding private trading. This rumor finds some strength in the better established report that certain accessories factories are now a state monopoly. One of these is concerned with ball bearings and has supplied all its war time output to the Government. If the rumor be correct, it will be helpful to the legitimate and orderly setting up of aircraft manufacture on a commercial basis, and it was largely because of the absence of this powerful help before the war that much of the languishing state of practical aeronautics in this country was due. The British government virtually has created and indirectly influenced the capital of this new industry, and it is fitting for it to continue its aid, just as years ago the torpedo and high-speed water craft were developed principally at national cost.

Reference to ball bearings prompts the remark that American interests are being increasingly felt here, and it looks as though the German pre-war monopoly here in these bearings is likely to be transferred, though not to the same extent, to the United States. Two or three makes are well known here, the tractors being the machines which seem to have drawn most attention to them. At present there seems to be a dearth of British makes of ball and roller bearings and an over-production of British magnetos.

Need National Highway System

One of the biggest, probably the largest development, concerned with the British motor industry, centers in the reorganizing of a national road system of motor transport. The railways, it is stated, will be nationalized, and virtually they are so already, in common with the canals or internal waterways, most of which the railway interests acquired years ago and have done nothing to develop or even continue the use of. Already the upkeep of the roads has become a national charge though the control was not unified.

Matters are shaping to a complete control by the state, both as regards the better use of the roads, for reducing congestion of railway traffic, and in respect of their cost of upkeep. Moreover it is known that there is a big scope of development of road traffic in perishable produce. Hitherto something like $95,000,000 was spent yearly on British roads by some 2500 local authorities, and now it is estimated that $500,000,000 is required to fit them to carry motor traffic of the sort intended.

Big Field for Road Development

A big field of development is promised which may be summed up as—

Extension of tractor farming and fruit and vegetable culture.

Increased speed of road traffic, especially for perishable stuff.

Development of rural and urban passenger traffic.

Encouragement for soldiers and others to settle on the land.

Encouragement of short and medium distance motor goods traffic of the heavier sort, this provision carrying with it the corresponding one of assured return journeys with adequate remunerative loads.

On this score it may be said that during the second half of the war period, government controlled efforts were made through the local chamber of commerce in some of the chief goods centers to develop motor road traffic for distances up to 100 miles. It has been stated by one traffic expert that railway transit is cheapest for distances exceeding 50 to 100 miles, and motor transit cheaper for distances under those limits, but this view may be modified where a better organization for return loads has been established on a sound basis. At the moment there is some important opposition to the government's scheme regarding the ministry of transport, there being a fear lest the railway interests may predominate in the working of the system.

Schemes for light railway lines corresponding to the roadside railways of Belgium are being discussed as supplementary means, and there is also the bigger prospect of a national electrification scheme to supply current at from one to two cents per unit from giant power stations erected near the coal pits and metallurgical gas furnaces. If a national system of motor road transport with roads adequate to the loads were available, direct use for 50,000 motor trucks could be found for the rural development hoped for.

There is and has been much criticism of the government's action in not declaring its intentions regarding the disposal of war trucks and in building a central truck repair depot near London. This depot has exceeded the provisional estimate of $5,000,000 by $3,750,000 and if completed doubtless will cost still more. It had its origin in two circumstances—the increasing number of idle vehicles "held up" for lack of repairing facilities, while the factories from which they came were daily adding to the number of new ones, and the issue accentuated by the mishap on the Western Front in March and the fears of a possible further "set back"; the effect being to reduce the available repair bases and depots.

The truck industry offered to deal with these vehicles at about 1/7 of the cost of the government scheme, under certain conditions, intended to recoup them for the outlay required. The virtual cessation of hostilities, of course, may, or may not, affect the utility of this scheme, but there can be little doubt that its necessity, if ever warranted on the grounds of urgency and economy, is now much reduced.

Both the manufacturers' and the public's points of view must be considered in this matter. The government has some 50,000 to 60,000 trucks in a generally repairable and usable condition. The manufacturers urge that they should have these vehicles of their own make returned to them to be repaired for re-sale to the public. One suggestion on this score was for the manufacturer to buy them back from the government, and another was for them to repair them at the national cost and be reimbursed at a scheduled rate.

From the public standpoint it is urged that these vehicles are national property and should not be accorded different treatment than is traditional with other army and public service stores listed for disposal.

Rigid Airships for Commercial Use

There has been published an official memorandum by the Air Ministry which sets out the merits of the airship against those of the airplane, regarded from the commercial standpoint. It is lengthy and its conclusions are in favor of the airship of the rigid type, on the following, among other, grounds:

Greater capacity and radius of useful flight of the airship for long distances and time in the air.

Greater capacity (the latest rigid German airship carrying over 38 tons gross, and has a cruising speed of 45 miles an hour, for 177½ hours, or seven days, and a gross distance capacity for 8000 miles in that period, with a maximum attainable speed of 77.6 miles an hour.

Relatively lower cost of the airship from the superior capacity denoted under the foregoing heads.

The objection that the airship is a fair-weather machine is replied to by the observation that during 1918 there were only nine days on which no airship flight could be made in the British Isles, which are recognized as one of the worst weather areas in the world.

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Am-pe-co in New Plant

MARSHALLTOWN, IA., March 19—The American Machine Products Co. has moved into its 3-story plant and has changed its trade-mark from Ampeco to Am-pe-co so that the pronunciation cannot be mistaken.

A. & B. Mfg. Co. To Make Hurlburt Trucks

NEW YORK CITY, March 17—The affairs of the Hurlburt Motor Truck Co., which went into the hands of creditors last month, seem to be working out satisfactorily through an agreement submitted to the creditors in open court on March 14, whereby the American & British Mfg. Co., Providence, will be licensed to manufacture 1,000 Hurlburt trucks in consideration of which it will pay the receiver of the Hurlburt company approximately $176,000 in cash as the trucks are sold. The A. & B. company will also purchase the Hurlburt parts on hand which are roughly estimated to be worth $150,000. The 1000 trucks will be sold by the Hurlburt Sales Co., a new corporation to be formed for the purpose.

The creditor's committee, consisting of H. G. Banta, Edward C. Striffler, Inc.; M. L. Bayard, Keystone-Hindley Gear Co.; and E. H. Brodwell, Fisk Rubber Co.; has reported that the business operations of the Hurlburt company from January 22 to March 4 produced a revenue of $124,716 at an expense of $110,796.29, leaving a profit of $13,919.71 to which should be added profit on work in process of $9,811.60, and profit on the service department of $5,292.18, making a total profit for the period of $29,023.49. The committee has been unable to estimate the liabilities to date but indicates that they will be between $850,000 and $1,000,000. All claims must be sent to the creditor's committee at once for consideration.

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Wire Wheel Brings Suit for Patent Infringement

NEW YORK, March 15—Suit has been brought by the Wire Wheel Corp. of America against the Budd Wheel Corp. The plaintiff claims infringement of the Pugh patent, No. 1,030,428, for the process of indenting and perforating the rims; of the Duffy patent, No. 1,125,498, for an automatic locking hub construction; of the Pugh patent, No. 903,608, for a protected lock, and of the House patent, No. 1,166,130, for a radially swinging lock.

The Wire Wheel Corp. of America has granted licenses to the Standard Roller Bearing Co., Philadelphia, which employs only the Pugh patent, No. 1,030,428; to the Hayes Wheel Co., Jackson, Mich., and the Dayton Wire Wheel Co., Dayton, which uses all four patents. The suit has been opened in the Eastern District of Virginia.

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Old Chandler Officers Re-elected

CLEVELAND, March 17—The officers of the Chandler Motor Car Co. were re-elected at the company's annual meeting as follows: President, F. C. Chandler; first vice-president, C. A. Emise; second vice-president, W. S. M. Mead; third vice-president, J. R. Hall; secretary, Isadore Grossman; treasurer, J. M. Regar. The only change in the company's directorate was the election of J. R. Hall, factory manager, to succeed J. V. Whitbeck, whose work as chief engineer interfered with his service as director. Mr. Whitbeck remains as chief engineer. Other directors, besides the officers, are: John Sherwin, Charles A. Otis and James A. Fayne.

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Premier Motor Corp. Appoints Executive Committee

INDIANAPOLIS, March 18—A committee of three has been formed to take over the active management of the Premier Motor Corp. This committee is just another name for the manufacturing committee which has been in control of several phases of the company's activities for some time, and is composed of the same members, C. S. Crawford, F. T. Nehrbas and E. F. Schaeffer. The manufacturing committee has been changed to the executive committee, so that it can take over some of the duties of the company's president, A. C. Flowers, who is unable at this time to devote all of his attention to Premier affairs.

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Buick Expansion

FLINT, March 17—The Buick Motor Car Co. has orders for every machine it can produce up to July 1. The company is now producing over 400 cars daily, and notwithstanding the set-back caused by war reconstruction hopes to equal its 1917 production of 135,000 cars. More men are now employed than when the armistice was signed.

A warehouse and loading dock have been completed, which can accommodate 1000 cars. By a double decking arrangement an additional 1000 machines can be stored. A new bronze and aluminum foundry is just being finished and will be in operation soon. The present foundry building, which adjoins the sheet metal plant, will be used for the further expansion of sheet metal work. A three-story building, designed and built for the manufacture of Liberty motors, has been completed, but inasmuch as peace has brought aircraft engine work to a halt, the new structure will house the tool designing department.

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Automobile & Supply, Ltd., New Canadian Incorporation

TORONTO, March 15—W. S. Smith and associates took over stock, trade, assets and good-will of the Automobile & Supply Co., Ltd. The new firm is being incorporated with the name of the old company shortened to Automobile & Supply, Ltd., and continues at the present premises. Automobile & Supply, Ltd., are distributers for Pierce-Arrow, Paige, Hupmobile and Gray-Dort passenger cars and Federal and Pierce-Arrow trucks.

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Tube Co. Buys $300,000 Site

DETROIT, March 18—The Detroit Seamless Steel Tube Co. has purchased a $300,000 site for its proposed $2,000,000 plant to be built within the next year. It is at West Warren and Wyoming Avenues and contains 60 acres.

Detroit Tractor Corp. Making $750 Tractor

DETROIT, March 18—The Detroit Culto-Tractor Corp., a newly organized concern, capitalized for $1,500,000, is about to place a $750 tractor on the market. The first machine has been completed and production will start on the first thousand about April 1. The company has completed arrangements for a manufacturing plant. H. M. Jerome, formerly chief engineer of the Allis-Chalmers Mfg. Co., is production manager as well as vice-president. S. R. DuBrie is chief engineer and secretary. Joseph A. Rowe is president, and E. H. Kramer treasurer.

Specifications of Tractor

The new tractor is a one-wheel drive machine. It is balanced by a side-wheel. The motor is V-type, 4 x 6, low compression, equipped with Bosch magneto, impulse starter, Stromberg carbureter, Pearce governor and air-washer. The gear ratio is 30 to 1, having a working speed of 2½ miles per hour with a drawbar pull of 1200 lb.

The water in the radiating tank is below the cylinders, so as soon as the motor stops all the water drains back into the tank. This eliminates all chance of the operator forgetting to drain the motor and prevents the cylinders from freezing. The arch straddling the rows has a clearance of 46 in. so corn that high may be passed over without injuring it. The total weight of the machine is 1800 lb. The company proposes to establish assembly plants in Seattle, Minneapolis, Kansas City and Dallas, and states that orders for 2500 machines are on hand.

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Standard Parts Now in Own Building

CLEVELAND, March 18—On the first of the month the Standard Parts Co. moved its central offices, which include the executive and supervisory staff, bookkeeping, advertising and contracting departments, to the Standard Parts Building on Walnut Avenue at East Eleventh Street, which has just been completed.

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National Wire Wheel Enlarges Plant

GENEVA, N. Y., March 17—The National Wire Wheel Works, Inc., maker of Pasco Wire Wheels, has arranged for additional factory equipment at Hagerstown, Maryland. With this and the present factory the company will be prepared by June 1 to manufacture 3000 wheels per day, and will arrange the equipment to still further increase this production as required. During the past year the concern has been practically entirely devoted to government production on airplane wheels and airplane parts. Direct factory selling branches have been opened in New York, Chicago, San Francisco, Kansas City, Dallas, Seattle and Minneapolis, as well as nine of the largest cities in Canada. Service stations have been equipped also in the larger cities.

A. O. Smith Building Rumors

MILWAUKEE, WIS., March 17—That the A. O. Smith Corp. is preparing to double the size and capacity of its plant at 27th Street and Keefe Avenue is the basis of well-defined rumors current here. Color has been lent to the reports by applications made in the last few days to the public land commission of Milwaukee seeking the vacation of certain streets adjacent to the present Smith works. At the general offices of the company it was stated that no statement was available at this time. Reports concerning the project are to the effect that construction work will begin as soon as technical matters on street vacation are adjusted. It is said that the additions will be ready for occupancy by Sept 1, at which time the Smith working force will be increased to 4,500 or 5,000 operatives.

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Madison to Make Trucks and Tractors

ANDERSON, IND., March 15—The Madison Motors & Tractor Corp., capitalized at $1,200,000, has been formed for the purpose of making tractors and trucks. This company is an outgrowth of the merger last fall of the Bull Tractor Co., Minneapolis, and the Madison Motors Corp., Anderson, formed for the purpose of making tractors and trucks for the United States Government during the period of the war. With the cessation of hostilities, however, the financial interests back of the companies determined to incorporate, and have added $500,000 of new capital, bringing assets and cash up to a sum in excess of $1,750,000. The company will build 1500 Bull tractors and 1000 Madison engines during the present year. C. E. Gibson is president, the directors including the president and L. N. Rosenbaum, manager; A. H. Ebert, C. H. Jockmus, eastern bankers, and J. F. Green, formerly president of the Bull Tractor Co.

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U. S. Tractor Co. to Build Plant

MENASHA, WIS., March 17—The reorganization of the United States Tractor Co., Chicago, as a Wisconsin corporation, styled the United States Tractor & Machinery Co., preparatory to the transfer of the works and general offices to this city, has been completed. The new company has a capital stock of $250,000 and the following Menasha men are incorporators: Joseph G. Sailor, George G. Barlow and Dr. A. B. Jensen. The first unit of the new plant will be erected at once. It will be a 1-story fireproof building, 60 x 150 ft.

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Nash Production Reaches 100 Mark

KENOSHA, WIS., March 15—The Nash Motors Corp. has completed its contract, which called for 1600 Quad trucks for the Government, and is winding up its war work. It is now devoting 90 per cent of its attention to its regular car production. In February 65 cars were produced daily. In March production will be increased to 90 cars, while the 100 mark will be reached early in April.

Current News of Factories

Notes of New Plants—Old Ones Enlarged

New Dodge Four-Door Sedan

NEW YORK, March 17—Dodge Brothers dealers are expecting deliveries within the next two weeks of a new four-door sedan which will sell for $100 more than the present two-door model, making the price of the new model $1,876. The chassis will be the same as at present.

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Baker R. & L. Co. to Make Custom Bodies

CLEVELAND, March 17—The Baker R. & L. Co., makers of the Rauch & Lang electrics and the Owen magnetic car, has entered the custom body field. Several years ago this company established a special body department, but until recently has confined its efforts to special designs for manufacturers and dealers, individual custom work not being solicited. Now, however, facilities have been expanded, and the company is producing original designs to meet the wishes of individual owners.

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Airplane Factory Will Close

MARBLEHEAD, MASS., March 17—The Burgess Co. airplane manufacturer, which employed 2000 people at its plant, will be closed Saturday. It turned out many of the training planes used by the government during the war.

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Flechter Opens Los Angeles Branch

NEW YORK, March 15—L. V. Flechter & Co. has opened a branch in Los Angeles. It is in charge of M. J. Siebert, who for ten years has been road salesman for the Neptune Meter Co., a subsidiary of the Flechter company. J. J. Frank has been appointed district manager of sales for the Metropolitan district.

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Frost Gear Adds

JACKSON, MICH. March 15—The Frost Gear & Forge Co., at the annual stockholders' meeting, increased its capital stock from $350,000 to $750,000, and approved plans for an addition, to be of steel construction, 75 x 150, with concrete basement, south of its present plant. The heat treating department will be located in the new building. All old officers and directors were re-elected.

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Gillette Rubber Takes Eau Claire Mfg. Co.

EAU CLAIRE, WIS., March 15—The Gillette Rubber Co. has taken over the plant and business of the Eau Claire Mfg. Co. for manufacturing machinery and equipment for the tire trade.

General Motors Drive on Trucks

LANSING, MICH., March 18—W. C. Durant, head of the General Motors Corp., has disclosed the general plan for the expansion of that company's property in Michigan. It provides for improvement in the Olds Motor Works as well as the embodying of the Reliance Engineering Co. plant into the General Motors unit in this city. The nature of the product it will turn out has not been revealed.

A substantial part of the General Motors appropriation for 1919 will be spent here. The general plan calls for additions to present factory buildings to care for proposed increased production, and a great increase in the working force.

The General Motors Corp. will go in extensively for trucks this season, a manufacturing adjunct not heretofore attempted in the Olds Motor Works plant.

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Making Ford Truck Bodies

OXFORD, MICH., March 18—Henry Houck & Son have organized here for the manufacture of truck bodies for Ford cars.

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Elgin Distributing Co. Opens

NEW YORK, March 17—The Elgin Motor Distributing Co. has been formed to take over the Metropolitan distribution of the Elgin. It is located at Broadway and Fifty-seventh Street. The company consists of: President, M. W. Sanger; vice-president, E. L. Sanger; secretary, Henry Weiss; treasurer, Harry Sanger, and assistant secretary, David Sanger.

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Velie Production Calls for 15,000

MOLINE, ILL., March 18—The Velie Motors Corp. is back from war to peace work, and is turning out on an average of 45 machines daily. The company aims to manufacture 15,000 cars this year.

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Produce Six Roamers Daily

KALAMAZOO, March 15—The Barley Motor Car Co. is at present producing at the rate of 6 cars a day and plans to increase this production at once. Recently the company's buildings have been completely rearranged with this increase in production in mind.

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Napoleon on 1 and 1½-Ton Trucks

TRAVERSE CITY, MICH., March 17—Active production of 1 and 1½-ton trucks has been started by the Napoleon Motors Co. The original plans of the company were to turn out about 864 Model 9 1-ton trucks and 136 Model 11 1½-tonners for 1919. The company, however, has now planned a larger production, ranging from eight to ten trucks daily, and, in order to facilitate this increase, has asked the Michigan Securities Commission for permission to sell the remaining $350,000 worth of the unsubscribed common stock. The 1-ton model sells for $1,285 and the 1½-tonner at $1,485. Both models have

overhead valve 35 hp. four-cylinder engines, 3½ by 5 in. With the exception of a difference in gear ratios, tire sizes and weight, the two models are alike. Other features include thermo-syphon cooling, Hotchkiss drive, Stromberg carbureter, Connecticut ignition and single unit Auto-Lite starter.

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Republic Sales Amount to $15,749,628

NEW YORK, March 17—Gross sales of $15,749,628 are reported in the financial statement of the Republic Rubber Corp. for the year ended Dec. 31. The net amount carried over as surplus for the year is $602,913.

The balance sheet for 1918 and 1917 is as follows:

Assets

Land, buildings, equipment, etc.	$4,606,973	$5,323,540
Investments in other companies	375,836	128,370
Inventories	6,843,245	5,159,268
Cash	493,885	483,759
Accounts and notes receivable	2,043,036	2,445,582
Due from officers and employees	126,817	29,797
Deferred stock subscriptions	512,780	.....
Stock contract with officers	.....	100,000
Unadjusted balance of proprietary selling companies	.....	232,618
Patents	2	1,054,601
Unpaid stock subscriptions	1,500,000	.....
Liberty bonds	61,070	.....
Miscellaneous investments	8,198	.....
Deferred items	146,645	402,287
Expenses applicable to future operations	109,425	.....
Total	$16,827,915	$15,359,822

Liabilities

Common stock	$1,634,010	$4,164,453
Preferred stock	8,867,400	6,755,400
Notes and accounts payable	6,088,718	3,291,715
Salaries and wages payable	.....	115,355
Accrued taxes, interest and preferred dividends	173,634	114,745
Reserves	37,093	918,154
Other liabilities	27,060	.....
Total	$16,827,915	$15,359,822

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Dividends Declared

Willys-Overland Co., Toledo, regular quarterly dividend on preferred, $1.75 per share, payable April 1 to stockholders of record March 20.

Firestone Tire & Rubber Co., Akron, quarterly on common, $1.50 per share, payable March 20 to stockholders of record March 10.

The Stutz Motor Car Co. of America, Inc., declared its regular quarterly dividend of $1.25, payable April 1 to stockholders of record March 22.

The Michigan Drop Forge Co., Pontiac, has declared a monthly dividend for March of 15 cents a share on common stock, payable April 1, to common stockholders of record March 15.

Keystone Tire & Rubber Co., Erie, Pa., declared a stock dividend of 15 per cent, payable May 20 to stockholders of record May 1; also the regular quarterly dividend of 3 per cent on the common stock, payable April 1 to stockholders of record March 21.

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Aviation School in Peru

WASHINGTON, March 18—A military aviation school will be established in Peru, according to a recent decree by the president of the country.

Studebaker Earns $3,884,195

Production Curtailed by Government Orders — New Plans Discussed

SOUTH BEND, March 17—The Studebaker Corp. of America shows net profits of $3,884,194 for the year ended Dec. 31, after all deductions were made, as compared with $3,500,741 in 1917.

The balance sheet of the Studebaker Corp., as of Dec. 31, 1918, compares as follows:

ASSETS

	1918	1917	1916
Plant, etc.	$17,922,076	$15,477,186	$13,437,983
Good will	19,807,277	19,807,277	19,807,277
Cash	2,875,005	2,528,555	3,196,703
Liberty bonds	980,750	.....	.....
Investments	796,371	847,672	1,142,044
Accounts and notes receivable	6,261,300	9,325,499	9,428,391
Due from U. S. and Brit. Gov.	8,205,829	.....	.....
Inventories	17,555,797	21,322,134	21,477,657
Deferred charges	268,918	358,684	235,493
Total	$74,673,923	$69,667,007	$68,725,549

LIABILITIES

Preferred stock	$10,775,000	$10,965,000	$10,965,000
Common stock	30,000,000	30,000,000	30,000,000
Notes payable	9,525,000	7,400,000	4,000,000
Deposits on sales contr.	214,352	.....	.....
Accounts payable	2,229,693	2,030,086	3,542,886
Advances	.....	285,212	342,111
Dealers' rebate reserve	.....	.....	689,320
Federal tax reserves	637,754	588,589	.....
Sundry creditors	771,149	543,389	1,964,694
Contingent reserves	1,358,237	1,358,237	1,358,237
Reserves for subcontractors' orders	749,101	.....	.....
Special surplus	2,835,000	2,548,654	2,548,654
Surplus	15,578,137	13,947,838	13,314,647
Total	$74,673,923	$69,667,007	$68,725,549

A. R. Erskine, president of the corporation, in his remarks to stockholders, explains the cutting down of production due to war orders, and the proposed enlargement of the company's plant. In 1918 the company produced 18,270 cars and 58,830 horse-drawn vehicles, of which about 50 per cent were delivered on war contracts. When the contract was given on May 18 for 155 millimeter shells at the rate of 4000 per day, $4,250,000 was provided for increased plant facilities. Complete war contracts called for:

Government	Ordered	Invoiced
United States	$30,792,221	$17,140,341
Sundry U. S. contractors	187,195	187,195
Total U. S.	$30,979,416	$17,327,536
British	18,946,135	14 962,385
French	1,351,250	1,351,250
Russian	3,801,551	3,801,551
Total	$55,078,353	$37,442,723

Of these government contracts, $8,200,000 is still due from the United States and Great Britain. From the standpoint of profits it is said that war contracts only netted 4.8 per cent. on sales.

Of the increased plant facilities undertaken to take care of war orders, one-half of a new machine shop was completed when the armistice was signed, two-thirds of a forge shop and the 8000-hp. power house. When finally completed the plant will have an annual capacity of 100,000 cars. In order to complete the new plant as soon as possible, the directors authorized the sale of $15,000,000 of 7 per cent ten-year serial gold notes, to provide funds for the floating debt of the company and to finance the plant extensions planned for this year. About one-third of the plant will be finished this year and by February, 1920, it will be producing 3000 cars a month.

The Detroit plants will continue in production of the more expensive cars and this city will take over the small model. The production schedule for 1919 calls for 40,000 cars. Plant No. 1, Detroit, heretofore used for car production, will be given over to manufacture, storage and shipping of parts. Plant No. 2, leased, used for parts storage only, will be given up. Plant No. 3, Detroit, will be used for car manufacture exclusively this year with castings, bodies, springs and some forgings supplied by the plant here. In the first quarter of this year 6500 cars will be produced and 4000 per month thereafter. Neither the company nor its dealers has a stock of cars on hand. By the end of December all war contracts were cancelled and the company is now back in steady commercial production.

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Lee Rubber & Tire Profits $200,348

NEW YORK, March 17—Net sales of the Lee Rubber & Tire Corp. were $4,609,924, or $536,029 ahead of 1917, according to the financial statement of the company for the year ended Dec. 31, 1918. Net profits, after all the necessary deductions were made, amounted to $200,348, or $177,759 more than $22,589 made last year.

The balance sheet for the last three years compares as follows:

Assets

	1918	1917	1916
Cash	$379,977	$155,960	$258,560
Accounts receivable	622,214	576,670	358,191
Liberty bonds	47,220	.....	.....
Inventories	1,322,794	1,576,729	1,601,442
Working funds at branches	3,000	9,142	112,312
Accrued interest	367	.....	.....
Deferred Chrgs.	9,259	27,781	28,540
Tire Sales stock	....	500	500
Plant and equipment	1,124,955	1,346,704	1,206,229
Patents, trademarks, etc.	376,770	400,300	400.300
Total	$3,886,556	$4,094,147	$3,966,078

Liabilities

Capital	2,433,591	2,433,591	2,433,591
Notes and accounts payable	675,203	1,150,911	1,075,814
Rent rec'd in advance	....	500	.....
Reserve for depreciation	291,661	231,661	191,661
Reserve for adjustment of tire claims	40,250	38,500	38,633
Employes stock option acct.	4,471	.....	.....
Income tax	.....	.....	9.982
Surplus	241,380	38,984	16.395
Total	$3,886,556	$4,094,147	$3,966,078

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Dividend Besides Profit Sharing

TOLEDO, March 18—Following an announcement recently of a $400,000 dividend on preferred stock, payable April 1, Clarence A. Earl, first vice-president of the Willys-Overland Co., stated that this dividend has no reference to the company's recently inaugurated 50-50 profit-sharing policy.

He explains that the dividend represents a return on invested capital, and that the profits to be divided with employees are those in excess of such dividends, and also legitimate compensation for labor. The dividend is the regular quarterly payment and is to be $1.75 on all preferred stock of record March 20. The Willys-Overland Co., as already stated, proposes to distribute to its employees one-half of all its profits over and above a fair return on invested capital.

Hayes Sales Increased $230,820 Over 1917

DETROIT, March 18—The Hayes Manufacturing Co. has placed on sale $800,000 cumulative preferred stock, bearing 8 per cent interest. Dividends are payable quarterly on the first days of February, May, August, and November.

Sales for 1918 increased $230,820 over 1917. Last year's sales totaled $3,753,381 as compared with $3,512,460 for 1917. During the last of 1918 about 40 per cent of production was war business, all of which has now been closed. These contracts are now being settled. Completed orders now on the company books total $1,250,000 for delivery before May 15.

The balance sheet, as of Dec. 31, 1918, is as follows:

Assets

	Dec. 31, 1918	Aug. 31, 1917	Mar. 31, 1916
Inventories	629,413	889,589	771,375
Notes and accounts rec'ble.	573,590	379,364	469,592
Investments	.....	39,317	95,675
Liberty Bonds	73,500	.....	.....
Cash	129,726	.....	.....
Other assets	.....	16,589	18,211
Total	$2,761,462	$2,226,983	$2,295,677

Liabilities

Capital stock	$2,300,000	$1,500,000	$1,500,000
Accounts and notes payable	225,141	607,455	358,698
Accrued payroll	24,682	44,473	67,447
Reserve for depreciation	.....	.....	131,913
Surplus	241,638	75,055	238,619
Total	$2.761.462	$2.226.983	$2.295.677

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Hart-Parr Report Shows $113,402 Net Loss

CHARLES CITY, IA., March 17—The annual report of the Hart-Parr Co. for the year 1918 shows net loss of $113,402. Comparison with previous reports is difficult because of a change in fiscal year, but the accomplishments of the company during the year were surprisingly favorable and are not all reflected in the balance sheet. Current liabilities were but 58.8 per cent of current assets, as compared to 79.7 per cent in the previous year. There was a charge off of $993,037 for bills receivable, obsolete inventories and other possible losses. Real estate was charged off to the amount of $577,649. The company has claims of $120,000 against the Government for work done during the year.

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Nash Reclassifies Capital

KENOSHA, WIS., March 17—In accordance with action taken by stockholders earlier in the year to enable employees to participate in the ownership of the company, the Nash Motors Co. has amended its corporate articles to the effect of reclassifying certain shares. The total capitalization is not increased by the change. The authorized capital includes 198,000 shares of preferred, par value $100, and 52,000 shares of common, without par value, or a total of 250,000 shares.

United States Exports of Automobiles and Parts by Countries, During January, 1919

Countries	Commercial Number	Commercial Dollars	Passenger Number	Passenger Dollars	Parts of Dollars
Denmark	...	.....	11	28,839	130
France	244	1,224,830	28	128,619	1,176
Greece	1	700	6	8,806	19,310
Iceland	...	.....	...	.....	584
Italy	...	.....	2	2,000	33,822
Netherlands	...	.....	6	27,618	.....
Norway	7	15,800	...	.....	10,477
Portugal	1	2,044	11	20,977	4,672
Spain	...	.....	9	11,976	2,844
England	17	34,176	5	5,795	150,130
Scotland	...	.....	...	.....	2,335
Ireland	...	.....	...	.....	2,423
British Honduras	...	.....	1	781	169
Canada	64	98,215	78	84,471	650,702
Costa Rica	...	.....	...	.....	4
Gautemala	4	9,900	5	4,300	368
Honduras	...	.....	...	.....	249
Nicaragua	1	4,000	...	.....	1,507
Panama	1	1,430	3	2,180	2,740
Salvador	...	.....	2	3,300	1,061
Mexico	73	113,019	163	217,934	50,853
Newfoundland	...	.....	1	893	606
Barbados	1	3,000	1	1,800	1,785
Jamaica	...	.....	3	5,400	5,133
Trinidad	...	.....	1	1,276	4,677
Other British West Indies	...	.....	1	936	14,122
Cuba	82	154,016	91	197,856	181,342
Virgin Islands	...	.....	...	.....	3,927
Dutch West Indies	...	.....	...	.....	184
French West Indies	2	1,233	2	2,250	14,440
Haiti	...	.....	22	18,558	4,314
Dominican Republic	1	2,523	11	16,598	1,468
Argentina	28	60,800	232	247,388	345,854
Bolivia	...	.....	...	.....	5,592
Brazil	...	.....	48	70,659	46,019
Chile	1	3,282	73	139,064	42,372
Colombia	...	.....	17	29,068	9,757
Ecuador	2	3,900	2	2,925	1,339
British Guiana	...	.....	2	2,250	6,587
Dutch Guiana	...	.....	...	.....	1,125
French Guiana	...	.....	...	.....	77
Peru	...	.....	31	58,413	16,261
Uruguay	1	2,600	44	108,673	45,969
Venezuela	...	.....	20	34,396	4,181
China	11	7,055	175	221,984	18,669
Chosen	...	.....	...	.....	4,970
British India	...	.....	1	985	35,858
Straits Settlements	11	12,156	7	8,432	2,195
Other British East Indies	3	4,000	...	.....	3,185
Dutch East Indies	16	38,554	79	116,632	42,649
French East Indies	...	.....	4	5,652	1,138
Hongkong	...	.....	16	22,033	3,176
Japan	273	462,217	229	310,684	121,665
Siam	...	.....	6	7,808	850
Australia	8	18,635	308	282,053	223,330
New Zealand	18	35,497	72	79,333	16,844
Other British Oceania	...	.....	3	2,535	344
French Oceania	...	.....	...	.....	618
German Oceania	...	.....	...	.....	667
Philippine Islands	13	32,116	156	211,147	148,208
British West Africa	...	.....	1	1,075	2,872
British South Africa	23	29,886	129	144,614	82,637
British East Africa	...	.....	19	15,415	4,038
French Africa	...	.....	...	.....	170
Liberia	...	.....	...	.....	13
Total	907	2,375,584	2,137	2,916,381	2,406,783

This table supplements the one which appeared in the March 6 issue of AUTOMOTIVE INDUSTRIES, *and gives figures for all of the individual countries including those generally grouped under the collective heading "Other Countries."*

20 Per Cent Increase in Hood Rubber Sales

BOSTON, March 19—Net sales of $22,341,081 are reported in the annual statement of Hood Rubber Co. for 1918. Compared with $18,573,765 in 1917, it is an increase of 20.2 per cent, and with $11,666,501 in 1916 is an increase of 91.5 per cent and 145.9 per cent over $9,083,693 in 1915. Of the 1918 sales about $5,000,000 were tires and $17,000,000 rubber footwear. Dividends of 12 per cent were paid on the $3,000,000 common stock in addition to 7 per cent on the $4,000,000 preferred, leaving $354,000 to be added to the surplus after deduction of taxes and depreciation. On Dec. 31 last the company had a working capital of $5,380,000, the largest in its history, and an increase of 64 per cent over 1916.

Following is its comparative balance sheet:

Assets

	1918	1917	1916
Plant	$4,000,000	$4,000,000	$2,900,000
Merchandise	8,$12,862	4,075,021	1,846,308
Accounts receivable	1,202,350	4,323,933	3,381,810
Cash	1,022,877	930,680	318,180
Stocks in other companies	285,400	184,400	159,400
Patents	1,000	1,000	1,000
Liberty bonds	521.020	233 096	.....
Total	$15,045,509	$13,748,131	$8,606,700

Liabilities

Common stock	$3,000,000	$3,000,000	$2,500,000
Prefer'd stock	4,000,000	4,000,000	2,750,000
Notes payable	4,725,000	4,150,000	2,280,000
Accounts payable	148,904	.....	.....
Surplus	2,666,605	2,312,291	1,076,700
Liberty bonds	505,000	285,840	.....
Total	$15,045,509	$13,748,131	$8,606,700

Manly Resigns from Curtiss

BUFFALO, March 18—Charles M. Manly, who has been vice-president of the Curtiss Aeroplane & Motor Corp., has resigned and will return to New York, where he will devote his attention to the development of the Manly Hydraulic Transmission System for motor trucks and will also open general engineering offices. Mr. Manly is president of the Society of Automotive Engineers.

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J. O. Hofbauer, formerly general sales manager of the Paige-Detroit Co., New York, has joined the Lexington Motor Co., New York, in a similar capacity. A. J. Wise will succeed him at the Paige-Detroit Co.

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Brigadier General B. P. Disque, who has had charge of spruce production for airplanes on the Pacific Coast, has been honorably discharged from the army.

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Captain V. K. McBride, Ordnance Department, who was at Jackson during the war and transferred to Detroit after the armistice, has been made assistant to E. W. Hurd, sales manager of the Premier Motor Corp., Indianapolis.

—

Frank Shaw, traffic manager of the Harroun Motors Corp., has resigned. Previous to joining the Harroun Co. he was connected with the Studebaker and Maxwell companies.

—

Major H. W. Alden has received his discharge from the army and has returned to Detroit. He is vice-president of the Timken-Detroit Axle Co. and will be active as consulting engineer.

—

H. L. Frost has been appointed production manager of the Parrett Tractor Co., Chicago Heights, Ill. He was formerly connected with the Ford Motor Co.

—

J. W. Flannery will be Eastern representative of the Corcoran Mfg. Co., Cincinnati.

—

Robert E. Page, for four and a half years assistant foreign sales manager for Dodge Brothers, has joined the Commerce Motor Car Co., Detroit, to act as a district sales manager in Canada.

—

Claude Greenhoe has been appointed chief engineer of the motor bearings division of the Hyatt Roller Bearing Co., Detroit, to succeed R. G. Wells, who has been promoted to chief engineer of the Hyatt factories at Newark, N. J. Mr. Greenhoe comes to the Hyatt company from the Militor Corp. Prior to that he was connected with the Republic Motor Truck Co., the King Motor Car Co. and the American Gear & Mfg. Co.

—

H. A. Goddard, former representative in Michigan for the Standard Parts Co., has resigned to take charge of the sales and advertising of the Militor Motors Corp., Jersey City, N. J.

Men of the Industry

Changes in Personnel and Position

Pomeroy Leaves Vauxhall Motors for America

NEW YORK, March 18—Laurence H. Pomeroy, technical director of the Vauxhall Motors, Lt., Luton, England, and engineer of the Vauxhall automobiles, is expected to arrive in America in a few days. Mr. Pomeroy has practically severed connections with the Vauxhall company, but retains the right to manufacture his design of car in the United States. His latest innovation is a valve-in-the-head 4-cylinder design known as the 30-98 Vauxhall, which has quite extraordinary performance records.

Mr. Pomeroy's paper on the value of valve-in-the-head engine design appeared in AUTOMOTIVE INDUSTRIES in two installments in the issues of Feb. 20 and 27. It was presented before the British Institution of Engineers.

—

J. H. Malone, advertising director of the Chilton publications, Philadelphia, has resigned to become vice-president and general manager of the William F. Hudson enterprises, Philadelphia, which include the Hudson Motor Specialties Co., Hudson Motor Axle Co., Precision & Thread Grinder Mfg. Co., and the Hudson Peck Machine Products Co.

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S. A. Host has resigned as director of publicity of the Lincoln Highway Assn. to become connected with the Lincoln Motor Co., Detroit, under Frank G. Eastman, advertising manager.

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Conroy Fiero, Washington, D. C. representative for the Buda Co., Harvey, Ill., has recently gone to Europe and will visit England, France, Belgium, Italy and, if possible, Russia, to investigate conditions for marketing Buda engines.

—

J. J. Callahan is in charge of the eastern branch office of the Moltrup Steel Products Co., Beaver Falls, Pa., which has recently been opened in the Woolworth Building, New York.

—

J. E. Duffield has been elected vice-president in charge of sales of the Essenkay Products Co., Chicago, and will assume his new duties immediately. Until recently he was general manager and treasurer of the Bailey Non-Stall Differential Corp.

—

M. H. Blank has been appointed chief engineer of the Lynite Laboratories of the Aluminum Castings Co., Cleveland. He was recently honorably discharged as captain in the army. Previous to entering military service he was assistant engineer of the Premier Motor Corp.

Wills Out of Ford

DETROIT, March 17—C. Harold Wills, one of the designers of the Ford automobile and a member of Henry Ford's organization for 18 years, has severed his connection with that company and will engage in business for himself. He was chief engineer of the Ford Co. and became associated with Mr. Ford two years before the present company was organized. He expects to open temporary offices here. The nature of his new business is not announced, but it is understood he will remain in the automotive field.

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Danish Firm to Represent American Industries

NEW YORK, March 15—Paul Fridericksen, representing Bendix Bros., Copenhagen, Denmark, is in America arranging for certain lines of motor cars, tractors, trucks and accessory representation. Bendix Bros. is a large firm which has handled farm machinery in Denmark, and has distribution through 300 or more dealers. Mr. Fridericksen is looking for two lines of motor cars and several accessories, such as tires, ignition apparatus, etc.

—

Frank W. Hammond, formerly with the Bates Tractor Co. and for a number of years connected with the sales department of the Lansing Wagon Co., has been placed in charge of the passenger cars agencies in eastern territory by the Reo Motor Car Co., with headquarters in Lansing.

—

John O. Munn, assistant advertising manager of the Willys-Overland Co., Toledo, has become advertising manager and assistant sales manager of the Republic Motor Truck Co., Alma, Mich.

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E. S. Leonard, Detroit, connected with the Garford Motor Truck Co., Lima, O., has been appointed sales manager of the White motor truck division of the Simons Sales Co., Detroit.

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Fred C. Warner, president of the Oakland Motor Car Co., Pontiac, has been elected president of the Chamber of Commerce of that city.

—

Ralph C. Chestnutt, formerly with the Willys-Overland Co., is now assistant chief engineer for the North American Motors Co., Pottstown, Pa.

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E. W. Snyder, for many years with J. B. Sipe & Co., is now with the Hilo Varnish Corp., Brooklyn. He will make his headquarters in Pittsburgh and represent the company in western Pennsylvania, eastern Ohio and northern West Virginia.

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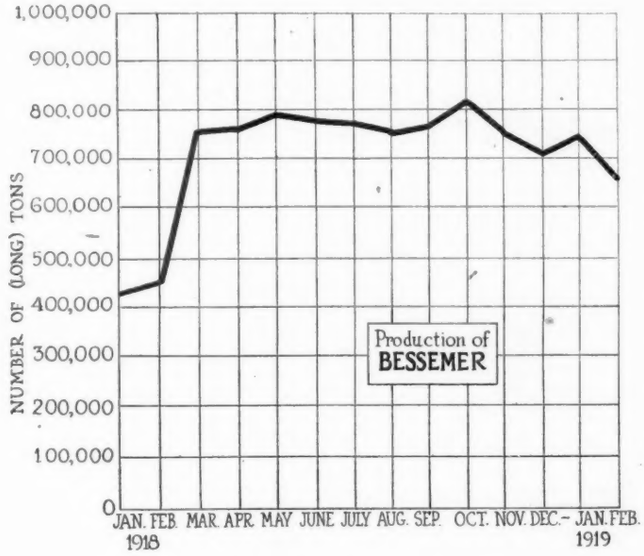
$2000 for Heinze Tractor

BOYNE CITY, MICH., March 17—The retail price of $2000 has been fixed on the Heinze four-wheel drive tractor by its manufacturer, the Traction Engine Co. of this city.

AUTOMOTIVE MATERIALS MARKETS

Materials Market Prices

Acids:		
Muriatic, lb.	.02	-.03
Phosphoric (85%)	.35	-.39
Sulphuric (60%), lb.	.008	
Aluminum:		
Ingot, lb.	.31	
Sheets (18 gage or more), lb	.42	
Antimony, lb.	.07	-.07⅛
Burlap:		
8 oz., yd	.06¼	
10½ oz., yd	.08½	
Copper:		
Elec., lb.	.14⅝	
Lake, lb.	.15½	
Fabric, Tire (17¼ oz.):		
Sea Is., combed, sq. yd.	1.50	
Egypt, combed, sq. yd.	1.25	
Egypt, carded, sq. yd.	1.15	
Peelers, combed, sq. yd.	1.10	
Peelers, carded, sq. yd.	1.00	
Fibre (⅛ in. sheet base), lb.	.50	
Graphite:		
Ceylon, lb.	.90	.22
Madagascar, lb.	.10	-.15
Mexico, lb.	.03¾	
Lard:		
Prime City, gal.	2.15-2.20	
Ex. No. 1, gal.	1.10-1.15	
Linseed, gal.	1.45-1.48	
Petroleum (crude):		
Kansas, bbl.	2.25	
Pennsylv'a, bbl.	4.00	
Manhaden (dark), gal.	.95	
Lead, lb.	.05	-.05¼
Leather:		
Hides, lb.	.24	-.39½
Nickel, lb.	.40	
Oil:		
Gasoline:		
Auto, gal.	.24½	
68 to 70 gal.	.30½	
Rubber:		
Plantation:		
First latex pale crepe, lb.	.53	
Brown crepe, thin, clear, lb.	.47	
Smoked, ribbed sheets, lb.	.52	
Para:		
Up River, fine, lb.	.56	
Up River, coarse, lb.	.34½	
Island, fine, lb.	.48	
Shellac (orange), lb.	.60	-.64
Spelter, lb.	.06¼	-.06½
Steel:		
Angle beams and channels, lb.	.03	
Automobile sheet (see sp. table).		
Cold rolled, lb.	.0625	
Hot rolled, lb.	.039	
Tin	.71	-.72
Tungsten, lb.	1.50-2.10	
Waste (cotton), lb.	.12¾	-.17



Production of Bessemer has been well maintained during the period from March, 1918, to January, 1919, inclusive. February, 1919, although showing a drop, is distinctly better than February, 1918

AUTOMOBILE SHEET PRICES

(Based on No. 22 Gage. Other gages at usual differentials)

	Primes only per 100 lbs.	Primes when seconds up to 15 per cent are taken per 100 lbs.
Automobile body stock	$5.95	$5.85
Automobile body stock, deep stamping	6.20	6.10
Automobile body stock, extra deep stamping	6.45	6.35
Hood, flat, fender, door and apron, or splash guard stock	6.05	5.95
Crown fender, cowl and radiator casing, extra deep stamping	6.55	6.45
Crown fender, cowl and radiator casing, deep stamping	6.30	6.20

Automobile Sheet Extras for Extreme Widths:

Nos. 17 and 18 over 36 in. to 44 in., 10c. per 100 lb.
Nos. 19 and 21 over 36 in. to 44 in., 30c. per 100 lb.
Nos. 22 to 24 over 26 in. to 40 in., 40c. per 100 lb.
Nos. 22 to 24 over 40 in. to 44 in., 80c. per 100 lb.

Blank Sheet Extras to Apply to Narrow Widths:

Oiling, 10c. per 100 lb.
Patent leveling, 25c. per 100 lb.

Resquaring, 5 per cent of gage price after quality, finish and size extras have been added.

Seconds 10 per cent. less than the invoice Pittsburgh price for corresponding primes.

Automotive Securities on the Chicago Exchange at Close March 15

	Bid	Asked	Net Ch'ge
Auto Body Company	8	9¼	+1¼
Briscoe Motor Car com.	10	..	..
Briscoe Motor Car pfd.	50	65	+10
*Chandler Motor Car	126⅞	128⅞	+2⅞
Chevrolet Motor Car	189	191	+25
Cole Motor Car Co.	90	105	..
Continental Motors com.	7¾	8¼	..
Continental Motors pfd.	97	..	..
Edmunds & Jones com.	15	20	..
Edmunds & Jones pfd.	75	90	..
Electric Storage Bat.	59	62	+7
Federal Motor Truck	35	37	+3
Fisher Body Co., com.	57	57½	+7
Fisher Body Co., pfd.	92	97½	—3
Ford Motor of Canada	300	310	..
General Motors com.	165½	166½	+9
General Motors pfd.	87⅝	89⅝	+2¾
Hupp Motor Car com.	8¾	9½	+1½
Hupp Motor Car pfd.	90	..	..
Kelsey Wheel Co. com.	40	44	..
Kelsey Wheel Co. pfd.	94½	96½	..
Manhattan Electric S. com.	..	48	..
Maxwell Motor com.	39½	40½	+4
Maxwell Motor 1st pfd.	67⅞	68⅞	+6⅞
Maxwell Motor 2d pfd.	30½	31½	+4¼
McCord Mfg. com.	30	34	..
McCord Mfg. pfd.	91	94	—2
Mitchell Motor Co.	27	32	..
Motor Products Corp.	..	35	..
Nash Motors Co. com.	215	230	..
Nash Motors Co. pfd.	95¼	100	..
National Motor Co.	15	20	..
Packard Motor Car com.	114	118	..
Packard Motor Car pfd.	100	102	..
Paige-Detroit Motor com.	28	29	..
Paige-Detroit Motor pfd.	8¾	9¾	..
Peerless Motor Truck	23	24	+2
Pierce-Arrow M. Car com.	44⅜	45⅜	..
Pierce-Arrow M. Car pfd.	104½	106	+1
Premier Motor Corp com.	5	..	..
Premier Motor Corp. pfd.	..	75	..
Prudden Wheel Co.	18	19	+ ½
Reo Motor Car Co.	23	24	+ ½
Republic M. Truck com.	35½	37½	..
Republic M. Truck pfd.	87	90	..
Saxon Motor Car com.	9¼	11¼	— ⅜
Scripps-Booth Corp.	21	25	..
*Stewart Warner S. Corp.	90	92	— ½
Stromberg Carburetor Co.	40	40¼	+1
Studebaker Corp. com.	63	64	+2¾
Studebaker Corp. pfd.	94	97	+4
Stutz Motor Car Co.	52½	53½	+3
United Motors Corp.	43¾	44¾	+1½
*White Motor Co.	53½	54½	+ ½
*Willys-Overland com.	27¼	28¼	..
Willys-Overland pfd.	92	93	+ ½

RUBBER STOCKS

	Bid	Asked	Net Ch'ge
Ajax Rubber Co.	74¼	75	..
*Firestone T. & R. com.	142	147	+2
Firestone T. & R. pfd.	99	101	..
Fisk Rubber Co. com.	104½	106½	— ½
Fisk Rubber Co. 1st pfd.	100	105	—5
Fisk Rubber 2d pfd.	100	105	+1
Fisk Rub. 1st pfd. conv.	99	101	—2
Goodrich, B. F., Co. com.	68¾	69¾	— ⅜
Goodrich, B. F., pfd.	106¼	106½	..
Goodyear T. & R. com.	275	280	+20
Goodyear T. & R. 1st pfd.	106	107	+1
Goodyear T. & R. 2d pfd.	106½	107½	+1½
Kelly-Springfield com.	119½	120½	—3
Kelly-Springfield pfd.	95	97	..
Lee Tire & Rubber Co.	25	26	— ½
Marathon Tire & Rubber	55	75	..
Miller Rubber Co. com.	166	170	..
Miller Rubber Co. pfd.	101	102	..
Rubber Products Co.	127	130	+5
Portage Rubber Co. com.	160	164	+28
Swinehart T. & R. Co.	80	85	..
U. S. Rubber Co. com.	82½	83	..
*U. S. Rubber Co. pfd.	111½	112½	..

*Ex dividend.

Calendar

ENGINEERING

April 2—Minneapolis Section, S. A. E. — Hotel Radisson. "Implements Designed for Tractor Belt Power and Their Characteristics."

SHOWS

March — Scranton, Pa. Thirteenth Regiment Armory, Scranton Automobile Assn.

March 15-22 — Boston, Mass. Boston Automobile Dealers' Assn. Passenger cars only. Chester I. Campbell, Manager.

March 15-22 — Harrisburg, Pa. Harrisburg Motor Dealers' Assn., Overland Warehouse. J. Clyde Myton, Manager.

March 17 - 22 — Great Falls, Mont. Montana Automobile Distributors' Assn.

March 17-22—Philadelphia, Pa. Motor Truck Assn., Commercial Museum.

March 18-22 — Zanesville, O. Third Annual, Zanesville Motor Car Dealers' Assn., City Hall and Market House. Edward B. Roemer, Manager.

March 19-22 — St. Joseph, Mo. St. Joseph Automobile Show Assn., Auditorium. John Albus, Manager.

March 19-22—Norfolk, Neb. Norfolk Automobile Show Assn.

March 19-22—Warren, Pa. Third Annual, Warren Automobile Dealers' Assn.

March 19-22—Charleston, W. Va. Kanawha County Auto Trade Assn., Armory. John B. Crowley, Manager.

March 20-22 — Champion, Ill. Truck show, Gymnasium of University of Illinois.

March 22-29—Pittsburgh Automobile Dealers' Assn. of Pittsburgh. John J. Bell, Manager.

March 24-26 — Harrisburg, Pa. Trucks, Harrisburg Motor Dealers' Assn.

March 24-29—Greenfield, Mass. Greenfield Automobile Dealers' Assn., State Armory. James J. Callahan (Pittsfield) Manager.

March 24-29—Utica, N. Y. Utica Motor Dealers' Assn.

March 25-29—Wilmington, Del. Fourth Annual, Wilmington Rink.

March 26-27 — Clinton, Ia. Fourth Annual Clinton County Automobile Dealers' Assn.

March 26-29—Watertown, N. Y. Tenth Annual, State Armory, Automobile Dealers, Inc. Arthur E. Sherwood, Manager.

March 27-29—Holdredge, Neb. Third Annual, Holdredge Automobile Dealers' Assn.

March 28-30—Peru, Ill. Illinois Valley Auto Show.

Third week March—Trenton, N. J. Trenton Auto Trade Assn. John L. Brock, Manager.

Last of March — Harlan, Ia. Southwestern Iowa Motor Exhibit.

March 29-April 5 — Passenger Cars. April 8-12—Trucks, Brooklyn. Brooklyn Motor Vehicle Dealers' Assn. I. C. Kirkman, Manager.

March 31-April 5—Cumberland, Md., Automobile Dealers' Assn., Armory.

March 31-Apr. 5—New Orleans, La. Henry B. Marks, Manager.

April 1-5—Denver, Col.—Denver Automobile Trades Assn. Stadium.

April 3 — Macon, Ga. Motor Truck Demonstration, Macon Automobile Chamber of Commerce.

April 5-12 — Bridgeton, N. J. Fourth Annual, Automobile Dealers' Assn.

April 5-12—Montreal, Can.—National Motor Show of Eastern Canada, Victoria Rink. T. C. Kirby, Manager.

April 8-12—Deadwood, S. D. Seventh Annual, Cars and Tractors, Deadwood Business Club.

April 16-19 — Waynesburg, Pa. Automobile Dealers' Assn. of Greene Co., Armory. Frank L. Hoover, Mgr.

April—Little Rock, Ark. Second Annual, Little Rock Automobile Dealers' Assn., Liberty Hall.

May 10-17—Bristol, Va.-Tenn. Cars, Trucks, Tractors, Airplanes and accessories. Bristol Chamber of Commerce. C. W. Roberts, Manager.

Not decided—Bridgeport, Conn. Auspices of City Battalion. B. B. Steiber, Manager.

Not decided—Indianapolis, Ind. Indianapolis Auto Trade Assn. John B. Orman, Manager.

June 2-6—Hot Springs, Va. Convention, Automotive Equipment Assn., Homestead Hotel.

*Oct. 15—Paris. Grand Palais, International Automobile Mfrs. Congress.

November—London — Olympia—International Automobile Mfrs. Congress.

TRACTOR SHOWS

March 26—Elmwood, N. J., Tractor Demonstration.

April 15—Walla Walla, Wash. Sectional Tractor Demonstrations.

May 5—Sacramento, Cal. Sectional Tractor Demonstrations, Demonstration Field.

June — Denver, Col. Sectional Tractor Demonstrations.

July—Wichita. Kan., Automotive Committee of National Implement Assn.

Aug.—Aberdeen, S. D. Sectional Tractor Demonstrations.

RACES

†March 23—Los Angeles. Ascot Speedway Assn., Ascot Speedway, 150 miles.

†May 17—Uniontown, Pa., probably 112½ miles.

†May 31—Indianapolis, Indianapolis Motor Speedway Assn.. 500 miles.

*July 5—Cincinnati, O., Speedway.

*July 19—Uniontown, Pa. Speedway race.

*July 26—Sheepshead Bay, L. I. Speedway race.

*Aug. 22-23—Elgin, Ill. Speedway.

*Aug. 23—Sheepshead Bay, L. I. Speedway race.

*Sept. 1—Uniontown, Pa. Speedway race.

*Sept. 20—Sheepshead Bay, L. I. Speedway race.

*Oct. 1—Cincinnati, O. Speedway race.

†Sanctioned.
*Tentative dates.

CONVENTIONS

April 10-12—Philadelphia. National Assn. of Motor Truck Sales Mgrs., Bellevue-Stratford.

April 24-26—Chicago — National Foreign Trade Council. Sixth National Foreign Trade Convention. Congress Hotel.

Foreign Trade Opportunities

WASHINGTON, March 15—The Bureau of Foreign and Domestic Commerce, Department of Commerce, has received requests for automobile or parts agencies of business from individuals and companies in foreign countries. These are listed below. For further information address the Bureau of Foreign and Domestic Commerce and specify the Foreign Trade Opportunity number.

A man in France desires an agency for the sale of motor cars. Correspondence may be in English. References have been supplied. No. 28670.

A firm in Norway wishes to purchase automobiles and supplies, and rubber goods. Payment, banker's confirmed credit in New York. Correspondence may be in English. References supplied. No. 28680.

A man in Algeria desires an agency for the sale of medium grade automobiles selling for about $1700. Correspondence may be in English. No. 28682.

A man in Mexico desires the sole agency for the sale of automobiles and supplies. References have been filed. Foreign Trade Opportunity No. 28364.

A man in France desires an agency for the sale of farm tractors. Correspondence should be in French. No. 28366.

An agency is desired by a man in Venezuela for the sale of automobiles. References have been filed. No. 28367.

A man in France desires an agency for the sale of motor cars and accessories. Correspondence should be in French. References have been filed. No. 28372.

A company in Australia wishes to secure an agency for the sale of all motor accessories and supplies. References have been filed. No. 28375.

An agency is desired by a man in France for the sale of farm tractors. Correspondence may be in English. References have been filed. No. 28384.

A man in France desires an agency for the sale of farm tractors. Correspondence may be in English. References have been filed. No. 28386.

An agency is desired by a man in Algeria for the sale of automobiles and farm tractors. Correspondence may be in French or Spanish. References have been filed. Foreign Trade Opportunity No. 28473.

A business man in France desires to purchase separate parts for engines and motor cars; and motor car and truck chassis. Correspondence may be in English. References have been filed. No. 28476.

A man in Spain desires to secure a general agency for the sale of farm tractors of from 10 to 12, 14 to 16 and 18 to 20 hp., operated by petroleum, gasoline and wood fuel. Quotations should be given f.o.b. New York. Correspondence should be in Spanish. No. 28477.

A man in Belgium wishes an agency for the sale of automobiles, trucks and farm tractors. Correspondence should be in French. No. 28485.

To Dispose of Surplus Acids

WASHINGTON, March 15—Surplus stocks of acids owned by the War Department are to be disposed of in co-operation with the acid committee and in such a way as not to affect the market. Approximate quantities held by the Government are as follows: Sulphuric acid, 4400 tons; oleum, 300 tons; nitric acid 1000 tons; mixed acid, 2600 tons; spent acid, 700 tons.